BULL. BOT. SURV. INDIA
Vol. 17, Nos. 1-4 : pp. 7-31, 1975

CONTRIBUTION TO THE POLLEN MORPHOLOGY OF THE FAMILY CAPPARACEAE.*

KRISHNA MITRA

Botanical Survey of India, Howrah

ABSTRACT

Present work deals with a detailed palynological investigation on 147 species distributed over 23 genera of the family Capparaceae. Most of these are Asian and African species with few American ones.

Pollen characters have been found useful in the delimitation of subfamily, tribe and genera to certain extent. In certain cases interspecific relationship is exposed by correlating pollen and seed characters together.

This study will be helpful in the living and fossil pollen analysis.

INTRODUCTION

"Ellipsoidisch, drei Falten, in Wasser dreistreifige Kugel" that is how Mohl (1834) described the pollen of Capparideae. He distinguished two types (a) *Capparis aegyptiaca, C. cynophallophora, C. tomentosa, C. spinosa, C. cafra* and *Cleome gigantea* with warts and (b) *Cleome violacea, Crataeva excelsa* without warts. Gaudichaud (1842) figured pollen of a Hawaiian species. Selling (1947) in his studies on Hawaiian pollen statistics gave a detailed account on *Capparis sandwichiana* DC. and *Cleome sandwicensis* A. Grey. Erdtman (1952) studied the pollen grains of 15 Capparaceae species distributed over 10 genera. Different workers (Zinderen Bakker, 1956; Ikuse, 1956; Vancampo, 1957; Guinet, 1962: Jain & Nanda, 1966; HoroWitz & Baum, 1967; Haddad, 1969; Nair, 1969; Maley, 1970; Mitra, 1970; Guers *et al.*, 1971 and Heusser, 1971), from time to time gave account on the pollen of this family. But a detailed investigation on the pollen morphology of Capparaceae is not attempted so far. Present study is an endeavour to fill up the lacuna to some extent.

The family Capparaceae is chiefly tropical and is more abundant in the drier parts of the tropics of the old and new world. It comprises of about 45 genera and about 700 species. *Capparis* and *Cleome* include the largest number of species and cover larger areas. Many genera are endemic to Africa and America only. India has got 6 genera (excluding *Niebuhria* and *Gynandropsis*) and about 53 species (Hooker f. & Thomson, 1872).

Two distinct groups are recognised on morphological characters:
I. Shrubs or tree. Fruit berried or capsule and II. Herbs. Fruit capsular.

Various botanists have tried to classify the family. The concept of classification of de Candolle (1823), Bentham & Hooker (1862) and Pax & Hoffman (1960) is similar in many aspects. Hutchinson (1967 & 1969) attempted a quite different classification. He recognised Cleomaceae and Oxystylidaceae (fam. novo affinis Cleomaceae) as a family distinct from Capparaceae. Under the subfamily Capparidioideae he raised many *Capparis* species to generic level.

---

*This is part of the work carried out in The Laboratoire de Palynologie, Faculté des Sciences, 34, Montpellier, France during the year 1971-72.

Harms (1960) treated Capparaceae under the order Rhoeodales sub order Capparidineae (including three families Capparidaceae, Tovariaceae and Cruciferae) in between sub order Rhoeodineae (Papavaraceae) and Resedineae (Resedaceae).

MATERIAL & METHODS

This study is based on most of the genera and the species of Asia and Africa. Few American species available for studies are also included. Pollen morphological studies on 240 species distributed over 23 genera and 147 species have been made. The polliniferous materials were collected from different herbarium and acetolysed (Erdtman, *l.c.*). Both chlorinated and non chlorinated pollen grains were mounted in glycerene jelly. Measurements were based on the mean of 25 measurements from non chlorinated pollen grains. Pollen terminology of Faegri and Iversen (1964) and Erdtman (*l.c.*) were followed. Camera lucida diagrams were drawn. The slides were preserved in the sporotheca of the Laboratoire de Palynologie, Faculté des Sciences, 34 Montpellier, France.

In the present investigation Pax and Hoffman's classification is followed for the interpretation and the exposition of the results obtained from the palynological investigation.

Abbreviations used : *Aperture* : Ect. ap.—Ectomaperture, Endo. ap. = Endo aperture. *Exine*: Psi. = Psilate, Ret. = Reticulate, Star. = Striate, Col. str. gr. = Columella in small striate group, Perf. = Perforate, Ech. = Echinulate, Sc. = Scabrate, Ver. = Verrucate, Rug. = Rugulate, P = Polar axis, E = Equatorial diameter, Op. = Operculate.

Abbreviation of the genera : A = Atmisquea, Ap. = Apophyllum, C. = Capparis, Cb. = Cadaba, Cl. = Cleome, Cla. = Cleomella, Cld. = Cladostemon, Cr. = Crataeva, Cris. = Cristatella, S. = Steriphoma, St. = Stixis.

OBSERVATION

General pollen morphological characters: The pollen is isopolar, elliptic longiaxis or spheroidal equiaxis. The number of aperture is always three (exception *Buchholzia* four), equatorially distributed and equidistant. The aperture may be colpate, colporoidate, colporate and operculate. The ectoaperture, colpa, is long, slit like. The endoaperture is distinct in colporate and operculate types. The former is with few teeth like granules at the periphery of the endoaperture or granules irregularly present at the endoaperture and the latter type is with a distinct or diffuse operculum. Both the colpate and colporoidate types are characterised by the distribution of granules. These granules may be distributed on whole of the colpal length in the colpate type and one-third or more of the colpal length in the colporoidate type. These granules are of ektexinous and endexinous in origin. The exine is tectate or semitectate; psilate, reticulate, striatoreticulate, scabrate and echinulate. The columella may be free to support a tectum or are fused in small isolated striate group. They may be long or short. In polar view the pollens are subtriangular.

The pollen grains of the family Capparaceae show diverse morphological characters. The pollen morphological characters of the 23 genera studied will be discussed below for the interpretation and their taxonomic significance.

Sub-Family: CAPPARIDOIDEAE

TRIBE I: 1. CAPPARIDEAE

Crataeva [Plate I: Fig. 1].

Pollen longiaxis oval. Polaraxis ranges from 20-33 μ and equatorial diameter 15-27 μ, 3 colporate. Ectoaperture, colpa, long extending upto poles gradually tapering. Colpi membrane psilate. Endoaperture more or less circular or irregular with few to many teeth like granular structure. Exine ornamentation regulo reticulate columella short, lumina (0.25-1 μ). Shape in polar view subtriangular.

Material studied:

C. adansonii DC. Gebel el Nuba, *Tuckholm Kedves* 146, Pr. 24939.

P 26-31=28.56 μ ; E 19-25=22·44 μ ; Ect. ap. 23×1·75 μ ; End. ap. 5×4 μ ; Exine 1·5 μ

—— Cameroun, *Maley* 279, Pr. 20014.

P 22-28=24.93 μ ; E 17-25=20.6 μ ; Ect. ap. 20×1 μ; End. ap. 5×5 μ; Exine 1·5 μ.

—— *Dakar*, Assemien labor Palyn. 200, Pr. 11420.

P 25-30=27.48 μ, E 21-25=23.52 μ; Ect. ap. 25×1 μ; End. ap. 5×5 μ ; Exine 1.5 μ.

C. excelsa Boj. *H. Straka*, Pr. 3297.

P 22-28=23.32 μ; E 18-23=20.84 μ ; Ect. ap. 19×3 μ ; End. ap. 5×5 μ ; Exine 1.5 μ.

C. obovata Vahl. *H. Straka* 1689, Pr. 3299.

P 21-25=23.52 μ ; E 15-20=18.2 μ ; Ect. ap. 20×1·5 μ; End. ap 5×4 μ; Exine 1.5 μ.

C. nurvala Buch.-Ham. Nepal, *V. Puri* 49, Pr. 9250.

P 27-32=28.5 μ; E 15-25=21.06 μ; Ecto. ap. 26×1.5 μ ; End. ap. 4×3 μ ; Exine 1·5 μ.

—— Cult. IBG., Pr. 7470.

P 25-30=27.65 μ ; E 18-22=20.19 μ ; Ect. ap. 24×1.5 μ; End. ap. 4×4 μ; Exine 1·5 μ.

—— Bihar, *Thothathri*, K. 9950 ; Pr. 24829.

P 24-30=26.32 μ ; E 20-23=20.92 μ; Ect. ap. 22×2 μ ; End. ap. 4×4 μ ; Exine 1.5 μ

C. religiosa Forst. India, Kallikota, *Ganjam* Dist. Herb. Pres. Coll. Madras Pr. 9046.

P 26-33=29.6 μ ; E 21-27=24.32 μ ; Ecto ap. 26×2 μ ; End. ap. 5×4.25 μ; Exine 2 μ

—— Herb. Pres. Coll. Madras Pr. 3857.

P 22-29=24.88 μ ; E 18-24=20.9 μ ; Ect. ap. 23×2 μ; End. ap. 4.75×4 μ; Exine 1·5 μ.

C. roxburghii DC. Burma, *Kurz, S.* 1803, Pr. 24827.

P 23-28=25·4 μ ; E 17-22=18.92 μ; Ect. ap. 24×1.5 μ ; End. ap. 4×4 μ ; Exine 1·5 μ.

The mean pollen grain size of *C. adensoni* and *C. religiosa/C. roxburghii* are comparatively larger than *C. excelsa* and *C. obovata*. Endoaperture is with few granular teeth in all except *C. obovata.* The exine reticulation is very fine in the Madagascarean species *C. excelsa* and *C. obovata* as compared to others. The African-species *C. adensonii* is similar to the Indian species *C. religiosa/C. roxburghii* in its pollen characters. Pollen morphologically it is not possible to distinguish these species.

Ritchiea [Plate I ; Fig. 2]

Pollen longiaxis, oval. Range of polar axis 30-40 μ and equatorial diameter 21-25 μ, colporate. Ectoaperture rather long, not extending upto poles, very gradually tapering, ends obtuse. The endoaperture is more or less circular with distinct bold 5 to 6 teeth. The exine ornamentation is very fine reticulate in *R. albersii* and rugulose or columella in small irregular group in *R. capparoides.* Latter species approaches *Maerua* species in its exine character.

Material studied :

R. albersii Gilg. Kenya, Forest dept. no. 3, Herb. de Geneve, Pr. 14081.

P 30-40=35.8 μ; E 21-25=23·72 μ; Ect. ap. 25.85×1 μ; End. ap. 4·2×5 μ ; Exine 2 μ.

R. capparoides (Andr.) Britten. Cote d' Ivoire. *R. Nozeran* 1850, Herb. Mont. PR. 24950.

P 31-38=37·84 μ ; E 21-25=23.72 μ ; Ect. ap. 24×2 μ ; End. ap. 6×6 μ ; Exine 2 μ.

Cladostemon [Plate I ; Fig. 3]

Pollen longiaxis, 3 colporate, colpa long, tapering, Endoaperture more or less circular with granules. Exine striatoreticulate or reticulate hetrobrochate at surface and striate below i.e., reticulate striate.

Material studied:

C. kirkii (Oliv.) Pax. Tanganyika, *Vaugham* 2525, Pr. 22732.

P 32-40=37·6 μ ; E 30-38=34 μ ; Ect. ap. 32×2 μ; End. ap. 4.5×5 μ; Exine 2.5 μ

Capparis [Plate I ; Fig. 4.6]

Pollen longiaxis, oval. Range of polar axis 14-47 μ and equatorial diameter 10-34 μ. 3 colporate. Ectoaperture, colpi, long, extending upto the pole. Endoaperture more or less circular with granular teeth. Exine ornamentation psilate, reticulate, rugulose, or perforate. The columella may be long or short.

On the pollen grain size the *Capparis* species can be grouped as follows:

Polar axis mean 15-19 μ
„ 20-25 μ
„ 26-40 μ

Pollen morphologically *Capparis* is quite homogeneous.

Material studied:

C. afzelii Pax. Cote d' Ivoire, *Aubreville,* Pr. 693.
P 20-27 = 23.32 μ; E 15-20 = 17.84 μ; Ect. ap. 18 × 1 μ; End. ap. 4 × 5.3 μ; Exine 2 μ.

C. andamanica King Andaman, *Dr. King's collector* 1892, Pr. 24817.
P 16-18 = 17.64 μ; E 12-15 = 13.52 μ Ect. ap. 15 × 1.75 μ; End. ap. 3.5 × 3.5 μ; Exine 1.5 μ.

C. angulata Ruiz. et Pavon Peru, Lambaye que Sapotal 8385, Pr. 8407.
P 35-47 = 39.5 μ; E 26-34 = 29 μ; Ect. ap. 34 × 3 μ; End. ap. 5.5 × 5 μ; Exine 3 μ

C. antanossarum Baill. *H. Straka* 1678, Pr. 3287.
P 15-22 = 17.47 μ; E 13-18 = 15.04 μ; Ect. ap. 15 × 1.5 μ; End. ap. 3 × 4 μ; Exine 1 μ.

C. avicenniaefolia H. Br. Equateur, *Spruce* 6402, Herb. Mont. Pr. 24969.
P 25-32 = 28 μ; E 18-23 = 30.28 μ; Ect. ap. 23 × 1 μ; End. ap. 3 × 3 μ; Exine 2.5 μ

C. bequaertii De Wild. Congo, Pr. 719.
P 28-37 = 33.7 μ; E. 21-26 = 23.42 μ; Ect. ap. 29.5 × 1 μ; End. ap. 5.5 × 4 μ; Exine 1.8 μ.

C. brevispina DC. Herb. P.C. 1935, Pr. 16374.
P 21-30 = 25.9 ; E 17-22 = 19.55 μ; Ect. ap. 22 × 5 μ; End. ap. 4 × 4 μ; Exine 1.5 μ.

C. breynia Linn. Annapurna ad vallee de la Magdalena, *Planchon* 322, Herb, Mont., Pr. 24977.
P 30-38 = 33.88 μ; E 23-28 = 26.24 μ; Ect. ap. 30 × 1 μ; End. ap. 7 × 5 μ; Exine 2 μ.

C. burmanica Coll. Burma, *Gilbert L. Rogers* 544, Pr. 24835.
P 18-22 = 19.64 μ; E 12-14 = 13.16 μ; Ect. ap. 17 × 1.8 μ; End. ap. 2.5 × 2.5 μ; Exine 1.5 μ

C. cartilaginea Decne. Arabie, Coll. *Mill. Rossignol,* Herb. Univ. Jerusalem, Pr. 10091.
P 15-18 = 16.6 μ; E 13-16 = 14.84 μ; Ect. ap. 13 × 2 μ; End. ap. 2.5 × 2.5 μ; Exine 1 μ

C. cathcarti Hemsl. ex Gamb, Sikkim, *Cave, G.H.* 18.5.1917. Pr. 24823.
P 17-20 = 18.68 μ; E 12-15 = 13.2 μ; Ect. ap. 14 × 2 μ; End. ap. 3 × 3 μ; Exine 1 μ

C. cleghornii Dunn. Mysore (India) *Raghavan, R. S.* 86945. BSI Pr. 17642.
P 19-23 = 20.8 μ; E 14-17 = 15.32 μ; Ect. ap. 16.5 × 1.5 μ; End. ap. 3 × 5 μ; Exine 1.5 μ.

C. corymbosa Lam. Senegal, *Maley* 358, Herb. Serv. Elev. Dakar, Pr. 33568.
P 19-24 = 21.56 μ; E 14-17 = 14.96 μ; Ect. ap. 17.3 × 1.5 μ; End. ap. 4 × 1.5 μ; Exine 1.25 μ.

—— Tchad, Mussafoyo *Alfort* no. 148 (30.7.64). Pr. 20242.
P 13-17 = 15.12 μ; E 10-13 = 12.08 μ; Ect. ap. 10 × 1 μ; End. ap. 1 × 1 μ; Exine 1 μ.

C. cynophallophora Linn. Herb. Univ. Mich. 1957. Pr. 4651.
P 23-30 = 25.88 μ; E 20-26 = 22.5 μ; Ect. ap. 20 × 4 μ; End. ap. 5 × 4 μ; Exine 1.5 μ.

C. decidua (Forsk.) Edgew. Poona (India) Western Circle, BSI 9540, Pr. 9249.
P 22-27 = 24.44 μ; E 18-22 = 20.3 μ; Ect. ap. 22.25 × 1.25 μ; End. ap. 5.5 × 4.4 μ; Exine 1.5 μ

—— Tchad, Ngouri ne du lac, *Maley* 7.8.67. Pr. 19857.
P 20-27 = 23.3 μ; E 15-20 = 17.3 μ; Ect. ap. 20 × 2 μ; End. ap. 5 × 4 μ; Exine 1.5 μ.

C. divaricata Lam. Coimbatore (India) *Subramanyam, K.* 2375. Pr. 9234.

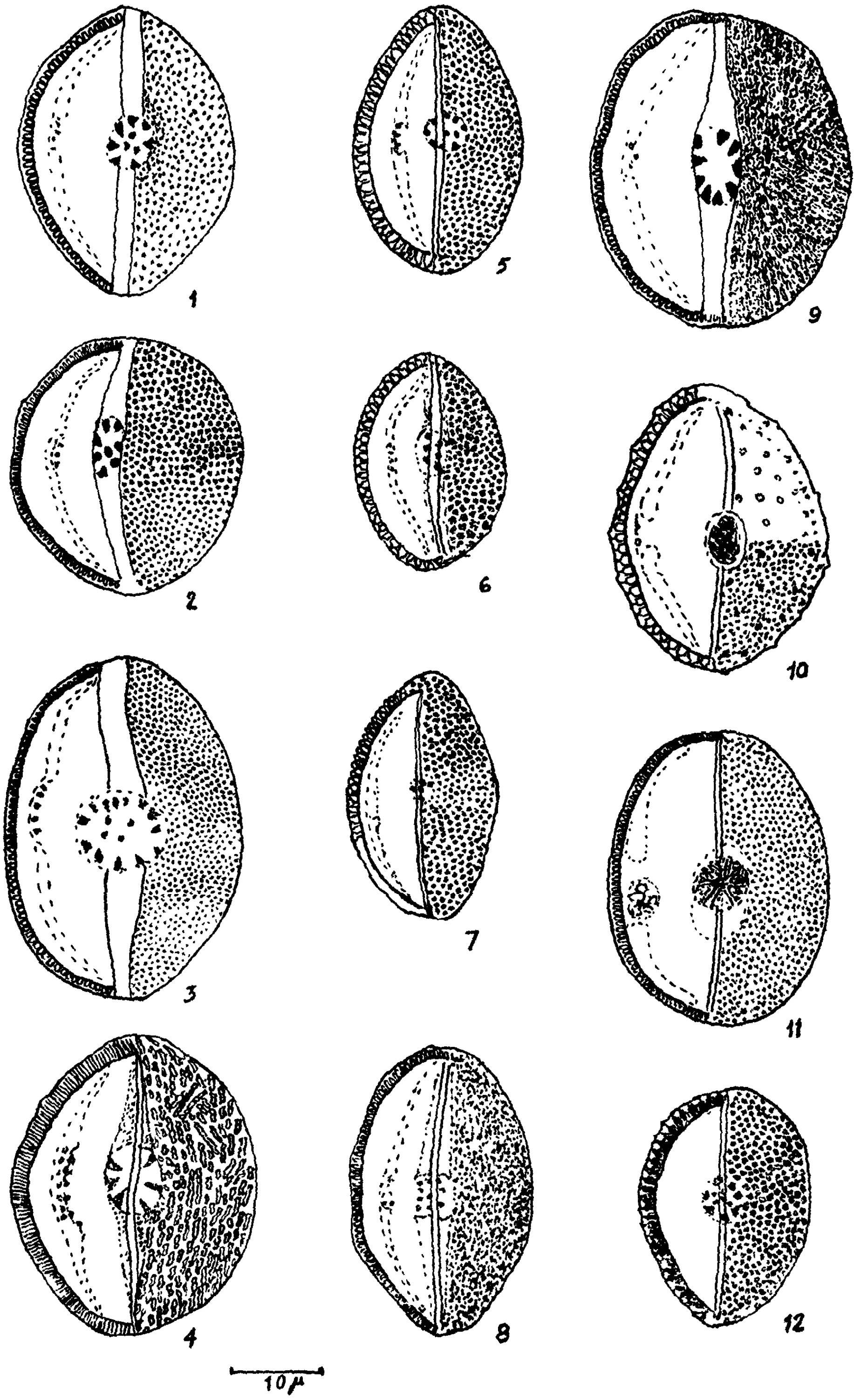

Plate I Camera lucida diagramme of different genera of Capparaceae.
Figs. 1-12: 1. *Crataeva adansonii.* 2. *Ritchiea albersii.* 3. *Cladostemon kirkii.* 4. *Capparis breynia.* 5. *C. avicenniaefolia.* 6. *C. flavicans.* 7. *Atamisquea emarginata.* 8. *Apophyllum anomalum.* 9. *Steriphoma cinnabarium.* 10. *Cadaba farinosa.* 11. *C. juncea.* 12. *Boscia coriacea.*

P 32-37=33.92 μ; E 24-28=25.5μ; Ect. ap. 28×2 μ; End. ap. 5×5μ; Exine 1.5μ.

—— Coimbatore (India) *Boume* 5088, Herb. Pres. Coll. Madras. Pr. 3856.

P 31-39=37.32 μ; E 27-33=30 μ; Ect. ap. 32.6×2 μ; End. ap. 7.6×6 μ; Exine 1.8μ

C. diversifolia Wight Coimbatore (India), *Subramanyam, K.* 2815. Pr. 9167.

P 19-23=21.04 μ; E 17-21=18.04 μ; Ect. ap. 18×2 μ; End. ap. 3.66×5 μ; Exine 1 μ

C. erythrocarpa Isert. Tisserant, *Oubangui*, R. P., Pr. 697.

P 21-27=24 μ; E 19-23=21.3μ; Ect. ap. 20×2 μ; End. ap. 5×5 μ; Exine 1.5 μ.

C. fascicularis DC. Tchad, Akaniode, *Maley* 39, Pr. 19119.

P 17-22=19.3μ; E 13-16=14μ; Ect. ap. 16×3μ; End. ap. 2.5×2 μ; Exine 1.5μ

C. flavicans Kurz Burma, *Collet, C. B.* 1887, Pr. 24861.

P 21-26=23.68 μ; E 17-20=18.84 μ; Ect. ap. 19×1.5 μ; End. ap. 3×3 μ; Exine 1.5μ.

C. fusifera Dunn Coimbatore (India) *Shetty, B. V.* 10215 BSI, Pr. 10251.

P 19-27=23.65μ; E 15-20=17.65μ; Ect. ap. 19×1.6 μ; End. ap. 2.5×3μ; Exine 1.5 μ.

C. grandiflora Wall. Melchegam, *Legris, P.*, Herb. I.F.P. Pr. 15120.

P 21-26=23.2 μ; E 14-18=16.55 μ; Ect. ap. 22×2μ; End. ap. 4×4 μ; Exine 1 μ.

—— Madras (India), *Subramanyam, K.* 2441, Pr. 9112.

P 27-31=28.84 μ; E 21-25=22.96μ; Ect. ap. 24.8×3 μ; End. ap. 5×5 μ; Exine 1 μ.

—— Herb. I.F.P., Pr. 9785.

P 19-26=22.56 μ; E 15-19=16.8 μ; Ect. ap. 20.5×1 μ; End. ap. 4×3 μ; Exine 1.5 μ.

C. grandis L. f. India, Tinnevelly, *Subramanyam*, K. 2852, Pr. 24843.

P 20-26=21.28 μ; E 15-17=15.92 μ; Ect. ap. 16.6×2 μ; End. ap. 5×4μ; Exine 1 μ.

—— India, Coimbatore, *Subramanyam, K.* 3046, Pr. 10254.

P 20-26=23.4 μ; E 12-17=15.9 μ; Ect. ap. 18×1 μ; End. ap. 3×3μ; Exine 1.5 μ.

C. heyneana Wall. India, N. Kanara, L. Js. 2539, Herb. P.C. Pr. 16369.

P 26-32=30μ; E 18-28=23.45 μ; Ect. ap. 26×2.5 μ; End. ap. 3×2 μ; Exine 2.5 μ.

C. horrida L. Nepal, *Puri, V.* 12, Pr. 24850.

P 15-20=17.8 μ; E 13-16=14.60μ; Ect. ap. 15.5×1.5 μ; End. ap. 2.5×2.5μ; Exine 1.5 μ.

C. lundellii Standley Herb. Univ. Mich. *Lundell* 3201 (1933). Pr. 4652.

P 30-35=32.15 μ; E 27-33=30μ; Ect. ap, 26.3×3 μ; End. ap. 5.5×4 μ; Exine 2 μ.

C. membranifolia Kurz Burma, *Kurz, S.* 1826, Pr. 24852.

P 16-20=18.04 μ; E 13-15=14 μ; Ect. ap. 24×1 μ; End. ap. 2.5×2.5μ; Exine 1.5 μ.

C. moonii Wight Herb. P. C. *Thani* 7329. Pr. 23947.

P 27-32=29.3 μ; E 18-25=21.4 μ; Ect. ap. 26×2 μ; End. ap. 4×3 μ; Exine 1.5μ

—— India, Poona, *Raghavan, R. S.* 79408; Pr. 24858.

P 24-27=24.9 μ; E 15-18=16.8 μ; Ect. ap. 18×1 μ; End. ap. 4×3 μ; Exine 1μ.

C. multiflora Hook. et Thoms. India, NEFA, *Panigrahi*, G. 5927. Pr. acetolysis 4.

P 18-20=19.22μ; E 16-19=17.07 μ; Ect. ap. 18.6×2 μ; End. ap. 3.75×5 μ; Exine 1.5 μ.

C. olacifolia Hook. f. et. Thoms. Nepal, *Rao, C. R.* 152, Pr.

P 22-27=23.76μ; E 18-22=19.4 μ; Ect. ap. 20×2 μ; End. ap. 5×5μ; Exine 1μ

—— India, Coimbatore, *Sebastine, K. M.* 5882, Pr. 5617.

P 24-28=26.68 μ; E 20-23=21.48μ; Ect. ap. 22.5×2 μ; End. ap. 4×5μ; Exine 1.5 μ.

—— India, Bengal, *Santapau, H. & S. K. Mukherjee*, 227. Pr. 24846.

P 21-25=23.48 μ; E 18-21=19.87 μ; Ect. ap. 20×2 μ; End. ap. 4.5×4.5 μ; Exine 1.5 μ.

C. parviflora Hook. f. et Thoms. India, S. Circle, BSI 5601, Pr. 9236.

P 14-18=15.6 μ; E 12-15=13.23 μ; Ect. ap. 14.6×1.5 μ; End. ap. 4×4 μ; Exine 1 μ.

C. prisca Macbr. Peru, Herb. Lima, Pr. 19177.

P 28-40=35.6 μ; E 20-30=24.42 μ, Ect. ap. 33×3 μ; End. ap. 6×6 μ; Exine 2 μ.

C. pyrifolia Lam. IBG cult. Pr. 8816.

P 22-31=28.1 μ; E 20-28=23.4 μ; Ect. ap. 23.3×1 μ; End. ap. 5×4 μ; Exine 1.5 μ.

C. richardii Baill. *Straka, H.* Pr. 3298.

P 16-21=18 μ; E 13-16=14.65 μ; Ect. ap. 17×2 μ; End. ap. 4×5.5 μ; Exine 1.5 μ.

C. rothii Oliv. Soudan Pr. 696.

P 20-26=22.72 μ; E 14-17=15.77 μ; Ect. ap. 20×1.5 μ; End. ap. 3×3.5 μ; Exine 1 μ.

C. roxburghii DC. India, Madras, *Sebastine, K. M.* 198, Pr. 9166.

P 20-23=21.32 μ; E 15-18=16.29 μ; Ect. ap. 18×1.6 μ; End. ap. 3.3×3.3 μ; Exine 1 μ.

C. sabiaefolia Hook. f. & Thoms. India, Naga hills, Manipur, *Mukherjee, S. K.* 2860, Pr. 9146.

P 16-21=18.52 μ; E 13-18=14 μ; Ect. ap. 18×1 μ; End. ap. 2×3 μ; Exine 1 μ

C. sepiaria L. India, Rajasthan, *Verma, D. M.* 3403, BSI, Pr. 24844.

P 14-16=15.6 μ; E 10-12=11.28 μ; Ect. ap. 12.5×1 μ; End. ap. 1.5×1.5 μ; Exine 1 μ.

—— India, Coimbatore, field no. 795, Pr. 9051.

P 14-17=14.88 μ; E 11-14=11.73 μ; Ect. ap. 12.5×1 μ; End. ap. 1.5×1.6 μ; Exine 1 μ.

—— Herb. P. C., *Thani* 7327, Pr. 23946.

P 15-17=16.56 μ; E 12-15=12.56 μ; Ect. ap. 14×1.5 μ; End. ap. 2×2 μ; Exine 1 μ.

—— India, Shenganipettai, *Legris, P.* I.F.P. 21.6.57. Pr. 18538.

P 14-18=16 μ; E 10-11=10.66 μ; Ect. ap. 12×1 μ; End. ap. 1.5×1.5 μ; Exine 0.5 μ

C. sicule Dunham Espana, *Murcia Wielles* 10428, Herb. Wielles Pr. 33502.

P 15-20=17 μ; E 13-15=14 μ; Ect. ap. 14×2 μ; End. ap. 2×2 μ; Exine 1 μ.

C. sicule Dunham Liban, *Nahar et Kalb.* 1934, Coll. *Mourde* 3215, Pr. 25011.

P 19-23=20.85 μ; E 15-18=16.65 μ; Ect. ap. 18.5×1.5 μ; End. ap. 3×3 μ; Exine 1 μ.

C. spinosa L. Ilem. Herb. Univ. Jeruselum, Coll. *Mille, Rossignol,* Pr. 10093.

P 20-22=21 μ; E 15-17=16.5 μ; Ect. ap. 20×3 μ; End. ap. 3×3 μ; Exine 1 μ.

—— var. *coriacea* Sahara central, Coll. *Reymond, A.* (1946), Pr. 6983.

P 19-22=20.2 μ; E 15-16=15.55 μ; Ect. ap. 18×2 μ; End. ap. 3×3 μ; Exine 1 μ

C. tomentosa Lam. Senegal Pr. 5828.

P 23-26=24.6 μ; E 16-17=16.8 μ; Ect. ap. 22×2 μ; End. ap. 4×2 μ; Exine 1.5 μ.

—— IFAN 25, Pr. 11342.

P 19-24=21.5 μ; E 15-18=16.5 μ; Ect. ap. 20×2 μ; End. ap. 4×5 μ; Exine 1.5 μ

—— Camaroun, *Maley* 263, Pr. 20012.

P 19-24=20.8 μ; E 15-18=16 μ; Ect. ap. 19.5×2 μ; End. ap. 3.3×3 μ; Exine 1 μ.

—— Erythree, Habab Terracioni, Herb. Gavioli, Pr. 33506.

P 17-22=19 μ; E 15-17=16 μ; Ect. ap. 18×2 μ; End. ap. 3×3 μ; Exine 1 μ

C. tenera Dalz. Burma, Capt. *MacGregore, B. W.* 1909. Pr. 24873.

P 17-20=19.04 μ; E 11-16=14 μ; Ect. ap. 16×2 μ; End. ap. 3×2 μ; Exine 1 μ.

C. viminea Hook. f. & Thoms. India, NEFA, *Rao, R. S.* 7382; Pr. 9200.

P 18-22=19.92 μ; E 12-18=14.33 μ; Ect. ap. 18×2 μ; End. ap. 3×5 μ; Exine 1 μ

C. zeylanica L. India, Pr. 5045.

P 21-24=22.4 μ; E 15-18=17 μ; Ect. ap. 20×2 μ; End. ap. 5.5×4 μ; Exine 1.5 μ.

C. zeylanica L. India. Andhra Pradesh, 16 Polavaram, agency, *Raju, D.C.S.*, Pr. 24869.

P 16-18=16.8 μ; E 13-15=14.12 μ; Ect. ap. 14 × 1·5 μ; End. ap. 2·5 × 3 μ; Exine 1·5 μ

Atamisquea [Plate I; Fig. 7].

Pollen longiaxis, 3 colporate, colpa long. Endoaperture circular with granules. Exine tectate, negative reticulate. Sub angular in polar view.

Material studied:

A. emarginata Miers. ex Hook. *Lorentz* 102: Herb. Montp. Pr. 24947.

P 21-27=29.16 μ; E 14-17=15.96 μ; Ect. ap. 18.66 × 1 μ; End. ap. 3.6 × 2.6 μ; Exine 1·5 μ.

Apophyllum [Plate I; Fig. 8].

Pollen longiaxis, 3 colporate, colpa long. Endoaperture circular with teeth. Exine rugulose reticulate. It has no resemblance with *Capparis decidua* in its pollen characters as according to Jacobs (1965) there is much convergence between these two genera in morphological characters and habit.

Material studied:

A. anomalum F.v.M. Nouvelle Galle du sud; *Dougall, M. C.* 1501; Herb. Sydney, Pr. 24945.

P 26-34=29.16 μ; E 18-21=19.6 μ; Ect. ap. 23·5 × 1.75 μ; End. ap. 5 × 3.6 μ; Exine 1·5 μ.

Steriphoma [Plate I; Fig. 9].

Pollen longiaxis, 3 colporate, colpi long, slit like in S. *cinnabarium* and tapering in *S. paradoxum*. Endoaperture more or less circular with granules. The exine is reticulate in the former and striatoreticulate in the latter species.

Material studied:

S. cinnabarium Gilg. ex Briquet (Syn.=*S. peruvianum* Spruce) Perou oriental; *Spruce, R.* 4128; Herb. Montp. Pr. 24942.

P 30-35=31·8 μ; E 24-29=27 μ; Ect. ap. 26·5 × 2.5 μ; End. ap. 5 × 4 μ; Exine 2 μ

S. paradoxum (Jacq.) Endl. Venezuela *Linden* No. 566, Herb. Mont. Pr. 24953.

P 29-40=36.32 μ; E 25-33=29·2 μ; Ect. ap. 34 × 2 μ; End. ap. 5 × 5 μ; Exine 2 μ

Cadaba [Plate I; Fig. 10-11].

Pollen longiaxis, 3 colporate. The size ranges from P 20-40 μ; E 12-13 μ Colpa long tapering. Endoaperture circular or lolongate with well developed or diffused operculum. In certain species the operculum is diffused and is constituted by teeth like structures. The exine is scabrate reticulate or striate.

The only species C. *madagascariensis* is without operculum and the aperture is 3 colporate with granules. Species with well developed operculum are quite homogeneous in their pollen character. Except *C. juncea*, with reticulate exine, all the *Cadaba* species are with scabrate or echinulate exine. Diffuse operculum reflects that it is constituted of granular structure.

Material studied:

C. farinosa Forsk. Tchad, Konomga; Pr. 20228.

P 24-32=27.63 μ; E 18-23=20·4 μ; Ect. ap. 22 × 2 μ; End. ap. 7 × 3 μ; Exine 1.5 μ.

—— Senegal, Pr. 5823.

P 29-37=33.64 μ; E 22-28=25·76 μ; Ect. ap. 30 × 1 μ; End. ap. 6 × 4 μ; Exine 1.8 μ.

—— Perigamalai, *Dabholkar, M. V.*, Herb. IFP. Pr. 18597.

P 30-40=34·16 μ; E 23-30=26.69 μ; Ect. ap. 27 × 2 μ; End. ap. 6.3 × 3.6 μ; Exine 2·5 μ.

C. fruticosa Druce Western Circle, BSI 61417; Pr. 9256.

P 29-36=32 μ; E 22-26=23.25 μ; Ect. ap. 27.4 × 1·3 μ; End. ap. 6.6 × 3·3 μ; Exine 1·5 μ.

C. gillettii R. A. Grah. Flore du East Ethopie, Vallee de l'Omo, Coll. *Cav, C. V.* 489, Herb. Afr. Est. Pr. 33641.

P 20-25=23.32 μ; E 11-18=16 μ; Ect. ap. 18 × 1·5 μ; End. ap. 3 × 1 μ; Exine 1 μ

C. glandulosa Forsk. Niger; Pr. 20169.

P 29-35=31.92 μ; E 21-29=24.26μ; Ect. ap. 25×2 μ; End. ap. 5.5×5.5 μ; Exine 2 μ.

C. heterotricha Stocks Flore du Kenya, Coll. *Greenway et Kanvis* 12832, Herb. Afr. Est. Pr. 33635.

P 24-28=26 μ; E 16-21=18.28μ; Ect. ap. 22.5×2 μ; End. ap. 4×4μ; Exine 1.5 μ.

C. indica Lam. India, Shambaganur, Herb. S. H. College, Det. Kew Pr. 9041.

P 33-43=39.86μ; E 21-28=26μ; Ect. ap. 31×1 μ; End. ap. 6.6×5μ; Exine 1.5μ.

—— India, Coimbatore, *Kistnaswamy, Naidoo,* T. 1884, Pr. 24815.

P 28-36=32.68μ; E 19-25=22.48μ; Ect. ap. 30×1 μ; End. ap. 5×4 μ; Exine 2μ

C. juncea (Sparrm) Harv. Cap du Bonne Esperange, *Schlocht* 1824; Herb. Montp. Pr. 24944.

P 24-35=30.58 μ; E 20-28=24.36μ; Ect. ap. 25×2.5 μ; End. ap. 5×4μ; Exine 1.5 μ.

C. kirkii Oliv. Tanganyka, Inst. Bot. Pankrakov, Pr. 18330.

P 23-28=25.65μ; E 17-22=20.3 μ; Ect. ap. 23×1.5 μ; End. ap. 4×4 μ; Exine 2μ

C. longifolia DC. Arabie, Bellevue *Prelev* 297, Herb. IEMTV Pr. 21837.

P 24-29=26.76μ; E 18-23=21.04 μ; Ect. ap. 22.5×1.75 μ; End. ap. 6×5 μ; Exine 1.5 μ.

C. madagascariensis Baill. *Straka, H.* 1681, 1682. Pr. 3289.

P 23-26=26.33 μ; E 18-24=21.22μ; Ect. ap. 23×1 μ; End. ap. 5×4 μ; Exine 1.5 μ

C. mirabilis Gilg. Flore du Kenya, S. Turkana Katamya Volcaro, Herb. Afr. Est. Pr. 33634.

P 24-32=28.92 μ; E 20-23=21.08 μ; Ect. ap. 27×2 μ; End. ap. 6×4 μ; Exine 1.5 μ.

C. rotundifolia Forsk. Flore du Kenya, Coll. *Carr. C. J.* 116, Herb. Afr. Est. Pr. 33637.

P 25-30=27.7 μ; E 18-22=19.5 μ; Ect. ap. 22×2 μ; End. ap. 4×2 μ; Exine 1.5 μ.

C. ruspolii Gilg. Folre du Kenya, Tana river Dist.; Coll. *Guillett, J. C.* 1165; Herb. Afr. Est. Pr. 33639.

P 24-30=26.32μ; E 19-23=20.88 μ; Ect. ap. 20×2μ; End. ap. 5×4μ; Exine 1.5μ

C. trifoliata Wight *Thani* 7328; Herb. Peradenya. Pr. 23960.

P 32-39=35.26μ; E 21-24=23.06μ; Ect. ap. 28.3×2.6 μ; End. ap. 5×3μ; Exine 1.5 μ.

—— India, Coimbatore, Alaya Hills, *Subramanyam, K.* BSI Pr. 6265.

P 33-40=35.64 μ; E 22-31=27.56μ; Ect. ap. 29×3 μ; End. ap. 5×7 μ; Exine 1.5 μ

—— India, Madras, *Subramanyam, K.* 2915, Pr. 9124.

P 27-35=30.8μ; E 20-25=22.5 μ; Ect. ap. 27.8×1.4 μ; End. ap. 6×5.6 μ; Exine 2.5 μ.

Boscia [Plate I; Fig. 12; Plate II; Fig. 1].

Pollen longiaxis, 3 colporate, colpa long, slit like. Endoaperture circular with teeth. Exine echinulate. Columella long, ornamentation reticulate.

B. salicifolia and *B. angustifolia* are with more echinulate exine than others. In exine ornamentation *B. coriacea, B. mossambicensis* and *B. urens* resemble *Maerua* species.

Material studied:

B. angustifolia A. Rich. Cote d' Ivoire, Pr. 685.

P 23-32=27.9μ; E 15-24=21.65μ; Ect. ap. 18×2 μ; End. ap. 3.5×5μ; Exine 3 μ.

—— Egypt, Red sea, Tebel wad Naboa, *Kedvas* No. 142, Pr. 24906.

P 19-27=25 μ; E 17-21=20 μ; Ect. ap. 20.75×2 μ; End. ap. 4×5μ; Exine 2μ

—— Tchad, Source Dogouro *Kourma* No. 888 H. Gillet, H. Pr. 12500.

P 24-32=27.2 μ; E 17-23=19.6μ; Ect. ap. 21×1.5μ; End. ap. 4.3×4μ; Exine 2.5 μ.

B. coriacea Pax Flore du Kenya, Yatta, K. F. Coll. *Miss M. Hucks* 1114, Herb. Afr. Est. Pr. 33636.

P 21-26 = 24.4 μ ; E 15-22 = 19.24 ; Ect. ap. 19.3 × 2 μ; End. ap. 4 × 4.5 μ ; Exine 2 μ

B. mossambicensis Klotzsch Flore du Kenya, Coll. *Polhill et Greenway* 442. Herb. Afr. Est. Pr. 33638.

P 29-36 = 33.24 μ ; E 21-27 = 24.37 μ ; Ect. ap. 24.66 × 2 μ; End. ap. 7.2 × 5 μ; Exine 3 μ.

B. salicifolia Oliv. Samanko Mali Reg. Bama Ko. J. et A. Raynal, Coll. *Alfort* 5388, Pr. 20245 μ.

P 20-26 = 23 μ; E 16.20 = 18.75 μ; Ect. ap. 20 × 2 μ; End. ap. 4 × 4 μ; Exine 2 μ.

B. sensgalensis Lam. ex Poir. Tchad, Neze, *Maley* No. 10, Sabillinia, Pr. 19749.

P 25-32 = 28.08 μ ; E 18-25 = 22.12 μ ; Ect. ap. 18.3 × 1 μ; End. ap. 4.6 × 4.6 μ; Exine 2.25 μ.

—— Dakar, Lab. Palyn. U.D. No. 217, *P. Assemien*, Pr. 11421.

B. urens Welw. Angola region Cotier, Herb Paris, Pr. 683 & 33541.

P 27-41 = 35.72 μ ; E 20-31 = 26.68 μ ; Ect. ap. 25 × 1 μ; End. ap. 4 × 4.5 μ ; Exine 2.5 μ

P 30-42 = 34.92 μ; E 20-34 = 27.52 μ ; Ect. ap. 24 × 2 μ ; End. ap. 5 × 6 μ ; Exine 2.5 μ.

Bucholzia [Plate II ; Fig. 2]

Brevaxis pollen, 4 colporate, colpi long slit like, in *B. macrothyrsa* and broad tapering in *B. coriacea*. Exine reticulate.

Pollen morphologically it is entirely different from all species. In general capparaceous species are with longiaxis, 3 colporate pollen grains. The characteristic granules are also not distinct.

Material studied :

B. coriacea Engl. Congo Belge, Pr. 33550.

P 24-33 = 29 μ; E 35-42 = 38.75 μ ; Ect. ap. 19 × 1.75 μμ; Exine 2.5

B macrothyrsa Gilg. et Bened. Oubangui, *Tisserant*, K.P. No. 1249, Pr. 33548.

P 25-33 = 30.25 μ; E 32-47 = 41 μ ; Ect. ap. 19 × 1 μ; Exine 3 μ.

Tribe I: 2. KOBERLINIEAE

Koeberlinia

Longiaxis pollen, 3 colporate, colpa long, slit like. Endoaperture with small granules. Exine reticulate.

It resembles in its pollen characters to certain species of *Capparis* and *Atamisquea*.

Material studied :

K. spinosa Zucc. New Mexico, *Wooton, E. O.* 146(P). Pr. 19913.

P 15-18 = 16.53 μ; E 15-18 = 16 μ ; Ect. ap. 16 × 1 μ ; End. ap. 2 × 2 μ ; Exine 1 μ

Tribe I: 3. MAERUEAE

Maerua [Plate II ; Fig. 3]

Pollen longiaxis, colpa long broad, slit like. Endoaperture circular with granules. Exine semi-tectate, collumella in small striate groups or striate groups on the surface and reticulate downwards or vice versa. In certain species the tectum is perforate. Pollen dimorphism in many species is noted.

The exine character is quite distinct from other genera. Except in *M. edulis, M. pseudopetalosa* and *M. duchesnii* with few distinct apertural granules, all the other species are with many small granules.

Material studied :

M. angolensis DC. Senegal, Dalua H. Serv. Elev. Dakar, *Maley* 49, Pr. 33584.

P 20-31 = 26 μ; E 15-25 = 21.5 μ; Ect. ap. 24 × 2.5 μ; End. ap. 5 × 4.2 μ; Exine 2 μ.

—— Arabie, Dilling Road forest reserve *Baumer*, Herb. Mont. Pr. 33563.

Large Pollen; P 27.32 = 30.55 μ ; E 18-25 = 23.35 μ ; Ect. ap. 21 × 3 μ ; End. ap. 3.5 × 3.5 μ ; Exine 2.25 μ

Small Pollen: Same material as cited above.

P 22-25 = 23.2 μ; E 17-20 = 18.35 μ; Ect. ap. 17 × 1.5 μ; End. ap. 2 × 3 μ; Exine 2 μ

—— Tchad, Herb. Fotius 1199, *Maley* 308, Pr. 33540.

P 22-31 = 26.42 μ; E 16-24 = 19.56 μ; Ect. ap. 24.6 × 2.5 μ; End. ap. 3.5 × 3.5 μ; Exine 2 μ.

—— Angola, Iona Savane, *Brazaville* 5741, Herb. Bot. Centre Africain, Pr. 24997.

P 21-28=24.84μ; E 17-22=19.32μ; Ect. ap. 20.6×2μ; End. ap. 4×4μ; Exine 1.5μ

M. angolensis DC. Tchad, *Mosnier* 404 (2.2.62), Pr. 20164.

P 23-33=28.6μ; E 19-25=21.08μ; Ect. ap. 23.6×1.5μ; End. ap. 2.37×2.75μ; Exine 2μ.

—— Senegal, *Berhut* 58, Pr. 14235.

P 28-32=29.64μ; E 20-26=25μ; Ect. ap. 21×1.5μ; End. ap. 3×4μ; Exine 2.5μ.

M. apetala (Roth.) M. Jacobs, Southern Circle, BSI 2375, Pr. 9228.

P 35-42=37.32μ; E 26-32=28.8μ; Ect. ap. 29.6×5μ; End. ap. 4×4μ; Exine 2.5μ.

—— India, Coimbatore, *Subramanyam, K.* 7810, Pr. 6321.

P 37-46=42.32μ; E 27-35=31.5μ; Ect. ap. 31×3.5μ; End. ap. 5×5.6μ; Exine 3μ

—— India, Bangalore, *Joseph, J.*, S. Circle, BSI 12396, Pr. 6156.

P 35-40=36.3μ; E 23-30=26.4μ; Ect. ap. 27.7×2.5μ; End. ap. 5×5.6μ; Exine 2μ.

—— India, cult. IBG, Calcutta, Pr. 5057.

P 30-44=38.68μ; E 25-37=32.26μ; Ect. ap. 28.3×4μ; End. ap. 6.6×8.6μ; Exine 2.8μ.

M. crassifolia Forsk. Libye, Djebel, Arkem, Pr. 13979.

P 28-37=32.05μ; E 22-28=24.8μ; Ect. ap. 23.3×1.6μ; End. ap. 4.5×4μ; Exine 3μ

—— Tchad, *Maley* 325, Pr. 19847.

P 23-30=24.7μ; E 15-20=18.47μ; Ect. ap. 18.5×2μ; End. ap. 3.6×5.4μ; Exine 1.75μ.

—— Mauritauis oued, Djeloua, Herb. Paris, Pr. 14209.

P 22-32=27.97μ; E 17-27=22.16μ; Ect. ap. 22.5×2μ; End. ap. 4.5×5μ; Exine 2.5μ

—— Wadi El Homeara L. *Kedvas* No. 148, Pr. 24938.

P 22-28=26.2μ; E 18-22=20.2μ; Ect. ap. 20×2μ; End. ap. 3.6×4μ; Exine 1.5μ.

M. duchesnei (De Wild) F. White, *Tisserant* 3751, Centre Africaine. Pr. 14220.

P 26-34=30.64μ; E 20-25=22.64μ; Ect. ap. 26×1.5μ; End. ap. 4×5μ; Exine 2.6μ

M. edulis (Gilg et Bene.) De Wolf *Kenia Bally* 5344, Herb de Genève, Pr. 14086.

P 35-50=41.8μ; E 22-30=27.26μ; Ect. ap. 34.6×1μ; End. ap. 3.75×5μ; Exine 2.5μ

M. kirkii (Olive.) F. White *Kenia Bally* B. 1597, Pr. 14941.

P 20-29=25.8μ; E 18-25×21.71μ; Ect. ap. 19.3×2μ; End. ap 3.5×4.5μ; Exine 2μ

M. nervosa Olive. Yemen, *Dafler* No. 683. Herb. Mont. Pr. 24962.

P 23-28=26.4μ; E 18-21=19.5μ; Ect. ap. 16×1.5μ; End. ap. 3.3×4.3μ; Exine 2μ.

M. nuda S. Elliot *H. Straka* 1683, Pr. 3291.

P 26-34=29.2μ; E 21-27=22.84μ; Ect. ap. 24.6×2μ; End. ap. 3×5μ; Exine 2μ

M. oblongifolia (Forsk.) A. Rich. Herb Peradeniya, *Thani* 7246, Pr. 23588.

P 28-36=31.9μ; E 23-28=25.5μ; Ect. ap. 24.2×1.5μ; End. ap. 4.6×4μ; Exine 2.5μ.

—— Tchad, Herb Leonard, No. 3386, Pr. 13999.

P 35-45=38.92μ; E 23-30=26.48μ; Ect. ap. 28×1μ; End. ap. 7.5×5.5μ; Exine 3μ.

M. ovalifolia Camb. Shillong, BSI (Eastern Circle), Pr. 9317.

P 27-33=29.4μ; E 18.23=21.63μ; Ect. ap. 26.25×2.37μ; End. ap. 4.5×5.3μ; Exine 1.75μ.

—— India, Calcutta IBG Cult. Pr. 9252.

P 26-33=30.44μ; E 19-32=23.9μ; Ect. ap. 21×1.5μ; End. ap. 3.3×5.6μ; Exine 2.5μ

M. pedunculosa Sim. Natal, Durban. Herb. Mont. *Medley Wood* 8294, Pr. 24957.

P 27-32=29.44μ; E 21-26=23.16μ; Ect. ap. 23.5×2.25μ; End. ap. 5×4.5μ; Exine 2.5μ.

M. pseudopetalosa DeWolf Zanzibar, Sagara *Sacleux* 1992, Herb. Paris, Pr. 14271.

P 29-41=35.48μ; E 20-28=23.92μ; Ect. ap. 28×1.5μ; End. ap. 3.87×5.82μ; Exine 2.5μ.

Thylachium

Pollen longiaxis, 3 colporate, colpa broad, Endoaperture circular or lalongate. Exine striatoreticulate. Columella long.

Material studied:

T. africanum Lour. Setim Mathew range, *J. Bally* 61. Herb de Genève. Pr. 14113.

P 35-40=37.65μ; E 22-27=25.43μ; Ect. ap. 27 × 1.2μ; End. ap. 5×4.5 μ; Exine 3μ.

—— Tanganyka Inst. Bot. Pankrakow. Pr. 18434.

P 42-48=43.72μ; E 26-35=30.81μ; Ect. ap. 25.75×3μ; End. ap. 2×4μ; Exine 3μ

—— Same as above Pr. 6890.

P 47-52=48.93μ; E 31-36=33.57μ; Ect. ap. 32.33×2μ; End. ap. 7×6μ; Exine 3μ

T. angustifolium Boj. *H. Straka* 1685, Pr. 3293.

P 27-36=31.75μ; E 20-24=22.75μ; Ect. ap. 29.5×3.75μ; End. ap. 6×6μ; Exine 2μ

T. seyrigii Hadj Moust. *H. Straka* 1684, Pr. 3292.

P 35-40=37μ; E 28-33=30.2μ; Ect. ap. 30×2μ; End. ap. 4×7μ; Exine 3.16μ

Tribe I: 4. STIXEAE

Stixis [Plate II; Fig. 4].

Pollen more or less equiaxis. 3 colporate, colpa long tapering. Endoaperture circular, granules not clear. Exine reticulate, hetrobrochate in *S. suaveolens* and homobrochate in the others. *S. longeracemosa* is with longiaxis pollen whereas the rest are equiaxis.

Jacobs (1963) referred *S. longeracemosa* under *S. ovata* (Korth.) Hall. f. sub. sp. *fasciculata* (King) Jacobs stat. novo, which also includes *S. fasciculata*. Pollen morphologically *S. longeracemosa* is distinct from other *Stixis* species due to longiaxis pollen.

Material studied:

S. fasciculata Gagnep. var. **tristis** *Therel* 3306, Mekong, Herb. Paris, Pr. 24955.

P 11-17=14.2μ; E 12-15=13.44μ; Ect. ap. 8×2μ; Exine 1μ

S. longeracemosa DC. Tonkin, *Balansa* 4073, Herb. Paris, Pr. 24989.

P 12-17=14.8μ; E 12-14=13.2μ; Ect. ap. 13×4μ; End. ap. 2×2μ; Exine 0.75μ.

S. obtusifolia (Hook. f. & Thoms.) Pierre Burma, *Kurz, S.* 1802, Pr. 24889.

P 9-12=10.87μ; E 9-12=10.62μ; Ect. ap. 8.5×1μ; End. ap. 1×1μ; Exine 1μ.

S. scandens Lour. Assam, *Fischer* 1880, Pr. 24819.

P 11-13=11.94μ; E 12-14=13μ; Ect. ap. 10 ×1.5μ; End. ap. 1×1μ; Exine 1μ.

S. suaveolens (Roxb.) Pierre Burma, *Cubitt, G. E. S.* No. 591, Pr. 24886.

P 12-15=13.88μ; E 13-15=13.84μ; Ect. ap. 8×2μ; End. ap. 2×2μ; Exine 1.5μ.

—— Sikkim, *King* 1877, Pr. 24891.

P 10-12=10.8μ; E 11-14=12.8μ; Ect. ap. 8.5×2μ; End. ap. 2×2.25μ; Exine 1.5 μ.

—— India, Calcutta, Cult. IBG. Pr. 24825.

P 11-16=12.96μ; E 10-15=13.4μ; Ect. ap. 10×2μ; End. ap. 1×1μ; Exine 1μ.

—— Chumbivalley, *Searight, G. L.* 138, Pr. 24813.

P 13-16=14.03μ; E 13-16=13.65μ; Ect. ap. 13.6×2μ; Exine 1μ

—— Herb. Peradeniya, *Thani* No. 7330, Pr. 23948.

P 16-20=18μ; E 15-18=16.4μ; Ect. ap. 16×2μ; Exine 1.5μ

Neothorelia [Plate II; Fig. 5]

Brevi or equiaxis pollen, 3 colporate, colpa long, slit like. Endoaperture not clear. Exine reticulate.

Material studied:

N. laotica Gagnep. Mekong. *Thorel* 3280. Herb. Paris, Pr. 24954.

P 9-12=10.56μ; E 10-12=11.16μ; Ect. ap. 9×1.5μ; Exine 1μ.

Sub-Family IV: DIPTERYGIOIDEAE

Dipterygium

Pollen longiaxis, 3 colporate, colpa long with granules all over the colpal length. Exine scabrate reticulate.

Material studied:

D. glaucum Decaisne, Herb. IEMVT, *Prelev* 314, Bellevue 1358, Pr. 21843.

P 20-23=21.69μ; E 17-19=17.95μ; Ect. ap. 18×2μ; Exine 1.5μ

Sub-Family VIII: CLEOMOIDEAE

Cleome (Plate II; Figs. 6-11).

Longiaxis pollen. The range of polar axis is 15-44 μ and equatorial diameter 13-38μ On the distribution of granules at the ecto-aperture the *Cleome* species can be grouped as follows:

Group I: 3 colporate, colpa long, more or less slit like. Endoaperture small circular or lalongate (*C. viscosa*) with distinct teeth like granules. Endoaperature is not distinct in some species. Exine mostly reticulate, striatoreticulate (*C. gynandra*) or reticulate scabrate or echinulate. This pollen character is associated with comparatively large seeds 2-3.5 mm with distinct ridges or striations.

Group II: 3 colporoidate, colpa long, slit like. Endoaperture not distinct. The granules are distributed about one-third of the colpal length at the center. Exine reticulate or mostly striatoreticulate. Seeds 0.5-1.75 mm (excluding hairs) with fine or dense hairs all over.

Group III: 3 coplate, colpa long, slit like. The apertural granules are distributed throughout the colpal length. Exine always echinulate or scabrate, reticulate and sometimes perforate. Seeds small 0.5-1.25 mm smooth or minutely pitted.

Material studied:

C. **aculeata** L. Macedoine, Tessalonique, Grece, Herb. Montp. Pr. 33537.

P 20-25=23.16 μ; E 16-19=17.2μ; Ect. ap. 20.3×1.5μ; End. ap. 7×1.5μ; Exine 1.5μ.

C. africana Botsch. Arabie, Al Khari, Riyadh, Coll. *Mosnier* 2766, *Maley* 135, Pr. 33552.

P 26-32=30.1μ; E 26-31=27.2μ; Ect. ap. 26×1.5μ; End. ap. 10×2μ; Exine 1.75μ.

C. amblyocarpa Barrt. et Murb. Tunisie, Bled Oudram, Herb. Montp. Pr. 33545.

P 26-31=29μ; E 21-27=24.2μ; Ect. ap. 26×1μ; End. ap. 11×1μ; Exine 2μ

C. angustifolia sub. sp. **petersiana** (Kl.) Kers Niger Coll. *P.de.F.* No. 535, Pr. 24553.

P 35-40=36.6μ; E 26-35=28.3μ; Ect. ap. 30.5×1 μ; Exine 1.75μ.

C. anomala H.B.K. Bagota 2670 m *Planchon*, Herb. Montp. Pr. 33531.

P 19-22=20.44 μ; E 16-18=17.48 μ; Ect. ap. 18×1.5μ; End. ap. 3×2μ; Exine 1μ

C. arabica L. Sahara Pr. 171.

P 35-42=37.08 μ; E 29-35=31.4μ; Ect. ap. 31.6×1 μ; Exine 2.6μ

—— Israel SS 1925, Herb. Univ. Jerusalem, Pr. 10089.

P 25-35=29.84μ; E 15-28=24.2μ; Ect. ap. 25.5×2μ; End. ap. 9×3μ; Exine 2.25μ.

—— Israel, Mille. *Rossignol*, Pr. 8792.

P 26-34=31μ; E 23-28=25μ; Ect. ap. 27.6×1 μ; End. ap. 10×2μ; Exine 2 μ.

—— Cairo & Suez, *Kedves* 145, Gunnar Tackholm, Pr. 24930.

P 27-34=31.34 μ; E 25-30=26.6μ; Ect. ap. 27.5×1.5 μ; End. ap. 12×1.5μ; Exine 1.5μ.

—— (=*C. trinervia*) Arabie, Buraikahzon epandouadi, Coll. *Mosnier* 3532, Pr. 33546.

P 23-31=27.1 μ; E 18-24=21.64μ; Ect. ap. 24.2×1.5 μ; End. ap. 10.3×2μ; Exine 1.75 μ.

C. areysiana Defl. Arabie, Bolad Fodhli, *Defler* 472, Herb. Montp. Pr. 33564.

P 18-21=19.64μ; E 13 μ; Ect. ap. 16.3×1 μ; End. ap. 3×3μ; Exine 0.75 μ.

C. aspera Koenig Madras beach 30.8.1916, Herb. P. C. Pr. 16370.

P 24-33=30.25 μ; E 16-19=17.7μ; Ect. ap. 22×1 μ; End. ap. 4.5×6.5 μ; Exine 1.5μ.

C. aurea Celak Macedoine, Tessalonique, Grece, Herb. Montp. Pr. 33537.

P 20-25=23.16μ; E 17-19=17.2 μ; Ect. ap. 20.3×1.5μ; End. ap. 7×1.5 μ; Exine 1.5 μ.

C. brachycarpa Vahl ex DC. India, BSI, Eastern Circle, Pr. 9312.

P 24-29=26.5μ; E 19-24=21.7μ; Ect. ap. 22×1 μ; Exine 1.5μ

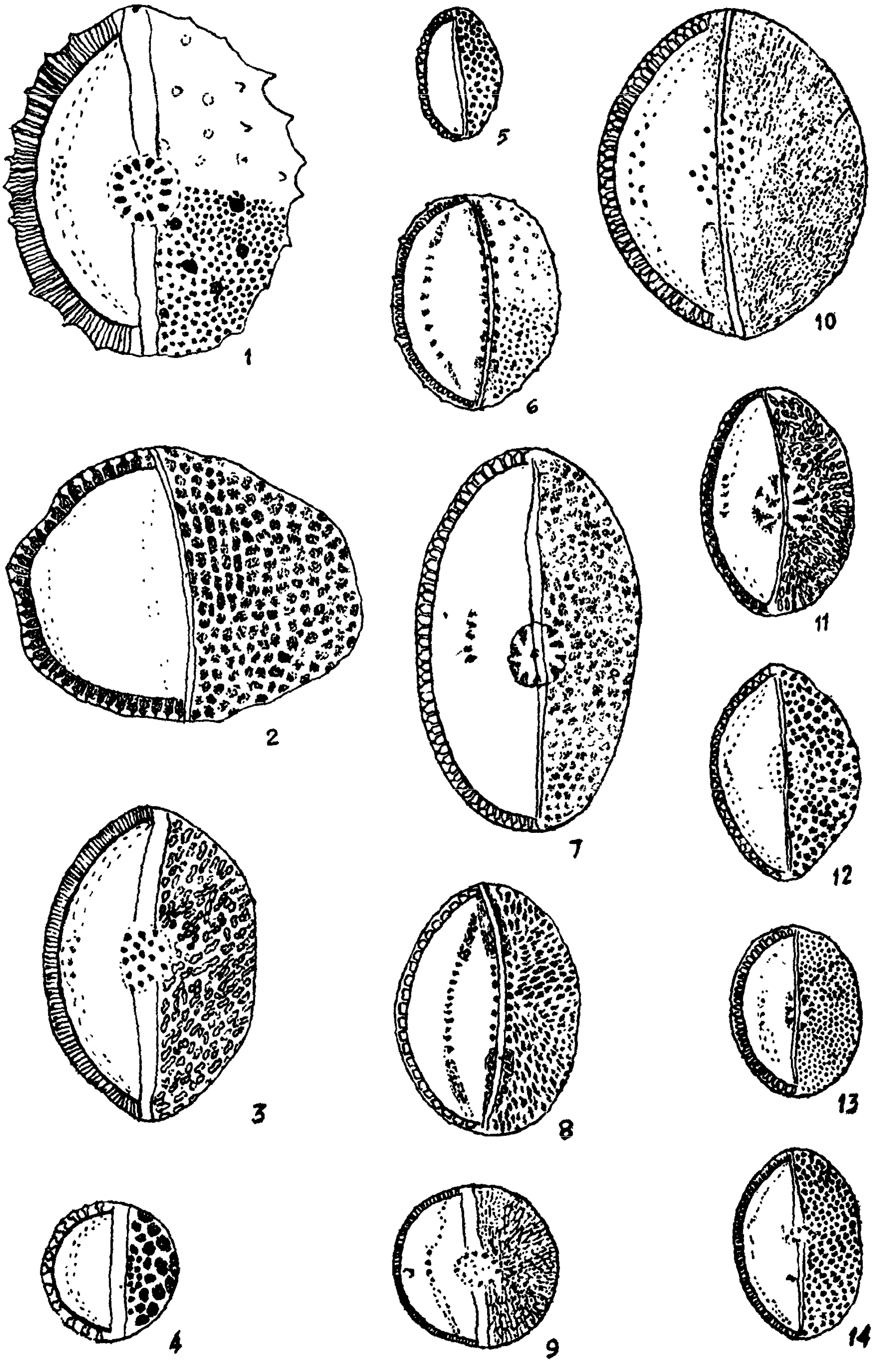

Plate II Camera lucida diagramme of different genera of Capparaceae.

Figs. 1-14 : 1. *Boscia urens*. 2. *Bucholzia macrothyrsa*. 3. *Maerua angolensis*. 4. *Stixis suaveolens*. 5. *Neothorelia laotica*. 6. *Cleome brachycarpa*. 7. *C. chodatiana*. 8. *C. colutoides*. 9. *C. gynandra*. 10. *C. paradoxa*. 11. *C. viscosa*. 12. *Cleomella obtusifolia*. 13. *Cristatella jamesii*. 14. *Dactylaenea micranthv*.

C. brachycarpa Vahl Sahara Central, Mt. Grebouns 1250, Kilion, Pr. 33534.

P 21-25=23.8μ; E 17-21=18.7μ; Ect. ap. 21.5×1 μ; Exine 1.5 μ.

—— Labo, de palynologie, Montp. Pr. 380.

P 17-22=20.28 μ; E 13-21=18.7μ; Ect. ap. 20×1 μ; Exine 1.5μ

—— Tchad, *Gaston* 524 Alfort 13.9.64, Pr. 19878.

P 23-28=26.1μ; E 18-23=20.4μ; Ect. ap. 22×1 μ; Exine 1.5μ

—— var. **angustifolia** Vahl Niger, Herb. IEMVT, Prelev 305, Bellevue, Pr. 21839.

P 34-44=38.48 μ; E 22-38=31.6μ; Ect. ap. 30×4μ; Exine 1.5μ.

C. chelidonii L. f. India, Coimbatore, *Sebastine, K. M.* 2521, Pr. 4320.

P 29-36=32.44μ; E 19-24=21.55μ; Ect. ap. 26×1.5μ; End. ap. 4.5×4.5μ; Exine 1.5μ.

—— India, Konkan Bell. Herb. P. C., Pr. 16441.

P 34-42=38.20μ; E 21-30=23.4μ; Ect. ap. 27×1.5μ; End. ap. 6×5μ; Exine 1.5μ.

C. chrysantha Decne Lybie, Djebel, Arkem, Herb. Leonard, Pr. 13607.

P 25-30=27.3μ; E 18-22=19.9μ; Ect. ap. 28×1μ; Exine 1.5μ

C. colutoides Bunge Iran, Teheran, *Emberger* 1956, Herb. Montp. Pr. 24970.

P 24-30=27.68μ; E 17-23=19.97μ; Ect. ap. 23×1 μ; End. ap. 10×1μ; Exine 1.5μ.

C. chodatiana Iltis Paraguay, *Hessler* No. 9506, Herb. Montp. Pr. 24952.

P 32-38=35.65μ; E 20-26=22.32μ; Ect. ap. 30×2μ; End. ap. 5.6×6.6μ; Exine 1.5μ.

C. decipiens Triana Amerique central, Quinzdio 2000 m. Herb. Montp. Pr. 33535.

P 22-26=24.36μ; E 18-21=19.72μ; Ect. ap. 20×1 μ; End. ap. 4.5×1 μ; Exine 1μ

C. droserifolia (Forsk.) Del. Arabie, Yemen (Aden) *Perottet* 1855, Pr. 33529.

P 24-31=27.48μ; E 20-24=22.4μ; Ect. ap. 22.6×1μ; End. ap. 7.6×2μ; Exine 1.5μ

C. dumosa (Boj.) Bak. *H. Straka* 1686, Pr. 3294.

P 21-26=23.92μ; E 16-21=18.16μ; Ect. ap. 21×1.5μ; Exine 1.5μ

C. felina Linn. f. India, South Indian plain, Herb. P. C. Pr. 16372.

P 26-41=34.3μ; E 19-23=20.4μ; Ect. ap. 28×1.5μ; End. ap. 7×4μ; Exine 2μ

—— Nagarjun Valley 9651, India, Pr. 24863.

P 28-33=30.56μ; E 17-20=18.57μ; Ect. ap. 26×2.5μ; End. ap. 5×4μ; Exine 1.5μ

C. gigantea L. Cultive a Talance, Herb. Mont. Pr. 33525.

P 27-33=29μ; E 25-30=28.16μ; Ect. ap. 26×2 μ; Exine 1μ.

C. glauca DC. Liban *Mouterde* 5071; Pr. 25019.

P 18-22=19.5μ; E 14-18=15.8μ; Ect. ap. 14×1μ; End. ap. 6×4μ; Exine 1.5μ

C. gynandra L. India, Calcutta, IBG; Pr. 7465.

P 19-22=20.64μ; E 14-17=15.89μ; Ect. ap. 17×1.5μ; End. ap. 2.7×3.8μ; Exine 1μ.

—— India, Hooghli, *Hazra, P. K.* 63/2689; Pr. 24865.

P 17-20=18.8μ; E 16-18=16.9μ; Ect. ap. 15.75×1μ; End. ap. 2×5μ; Exine 1.5μ

—— India, Coimbatore, *Subramanyam, K.* 376, Pr. 24850.

P 15-20=17.34μ; E 13-17=14.92μ; Ect. ap. 14.5×2μ; End. ap. 3.6×3.6μ; Exine 1μ.

—— India, Bengal field No. 256, Pr. 9063.

P 21-23=21.9μ; E 16-19=17.4μ; Ect. ap. 19×1μ; End. ap. 2×4μ; Exine 1.5μ.

——Dakar, Lab. Dalyn. UDN 149; Pr. 11422.

P 18-21=19.5μ; E. 16×18=16.73μ; Ect. ap. 17.15×1.5μ; End. ap. 2×3μ; Exine 1μ.

C. gynandra L. Soudan, E. L. Dabba Exp. *Kedvas* 14, Pr. 24432.

P 16-20=17.55μ; E 13-17=15.1μ; Ect. ap. 14×1μ; End. ap. 1.5×1.5μ ; Exine 1μ.

—— India, Pondicherry, *Guinet* 11.10.61. Pr. 5510.

P 20-25=22μ ; E 16-18=17μ ; Ect. ap. 20×1μ; End. ap. 5×5μ; Exine 1.5μ

—— Madagascar, *H. Straka* 1688 ; Pr. 3296.

P 17-21=18.52μ ; E 14-18=15.72μ ; Ect. ap. 18×1.5μ; End. ap. 1.5×4μ; Exine 1μ.

C. hanburyana Penzig Arabie, Herb. I.E.M.V.T. Bellevue 1346, Pr. 21838.

P 17-20=18.3μ; E 13-16=14.59μ ; Ect. ap. 16×2μ; Exine 1μ.

C. leptorachis Ruiz. Chilli, *J. Gay* 1403, Herb. Mont. Pr. 33524.

P 20-25=22.88μ; E 16-22=18μ ; Ect. ap. 18×1μ; End. ap. 3.5×1μ; Exine 1μ

C. leptostachys Planch. & Linder Bagota, *F. Felix* 28, Herb. Mont. Pr. 33557.

P 21-27=23.92μ ; E 18-24=20.53μ ; Ect. ap. 21×1μ ; End. ap. 3.5×2μ ; Exine 1μ.

C. maculata Burtt. Transvaal, *Schlechter* 3714. Herb. Mont. Pr. 33558.

P 22-28=26μ ; E 15-17=16.2μ; Ect. ap. 23×1μ; End. ap. 3×3μ ; Exine 1μ

C. monophylla Linn. India, Coimbatore, *Subramanyam*, K. 623, Pr. 24839.

P 22-27=24.6μ ; E 16-20=19.04μ; Ect. ap. 18×1.5μ; End. ap. 2.2×5μ ; Exine 1.75μ

—— India, Orissa, *Panigrahi, G.* 20516, Pr. 4314.

P 25-30=26.92μ; E 19-23=20.76μ; Ect. ap. 22.3×1μ; End. ap. 3.5×5μ; Exine 1.5μ.

—— Arabie, Kawer, *Baumer* 1958, Herb. Mont. Pr. 33536.

P 25-32=28.25μ; E 18-25=21.4μ; Ect. ap. 25×2μ; End. ap. 3×8μ; Exine 1.5μ.

—— Tchad, *Gillet, H.* 2184, Pr. 12489.

P 25-32=28.25μ; E 17-24×19.68μ; Ect. ap. 21×2μ ; End. ap. 4.5×4.5μ ; Exine 1.75μ.

—— Tchad, *Bengone Audru* No. 252, Pr. 20810.

P 27-33=29.45μ; E 19-28=23.75μ ; Ect. ap. 21.5×1μ; End. ap. 3.5×6μ; Exine 1.5μ

—— Arabie, Herb. IEMVT Bellevue 1352, Pr. 21840.

P 27-31=28.76μ; E 20-24=22.08μ; Ect. ap. 22.5×1.6μ; End. ap. 4×4μ; Exine 1.5μ.

—— Lab. Palyn. Montp. Pr. 15340.

P 26-31=27.88μ; E 19-26=23.6μ; Ect. ap. 23×2μ; End. ap. 4×7.5μ; Exine 2.6μ.

—— India, Coimbatore, *Sebastine, K. M.* 1359, Pr. 4307.

P 23-26=24.6μ; E 16-20=17.64μ; Ect. ap. 19.3×1μ; End. ap. 2.75×5.25μ; Exine 1.5μ.

C. papillosa Steud. Sahara Central, *Monod* 363 (1927), Herb. Montp. Pr. 24946.

P 16-20=17.84μ; E 12-17=14.72μ; Ect. ap. 15×1μ; Exine 1μ

—— Tchad, *Gillet, H.* 1183 ; Pr. 22509.

P 13-18=15.58μ; E 12-16=14.4μ ; Ect. ap. 13×1.5μ; Exine 1μ.

C. paradoxa R. Br. Arabie, Abes Fas el Meffatch, *Baumer* 1560, Herb. Montp. Pr. 24996.

P 34-39=36μ; E 27-31=29μ; Ect. ap. 33.5×2μ; End. ap. 15×2μ; Exine 2μ.

—— Nubie, Iogodels, *Ehrenberg* 1820. Herb. Montp. Pr. 24979.

P 31-33=32.33μ; E 23-28=26μ ; Ect. ap. 27×1.5μ; Exine 2μ.

C. pungens Willd. Cult. Montp. 1865. Pr. 33556.

P 24-32=28.56μ; E 17-22=19.44μ; Ect. ap. 23×1μ ; End. ap. 6×1μ ; Exine 1μ

C. rosea Vahl Brasil, Organ Montairis, Herb. Montp. Pr. 33554.

P 19-24=22.6μ; E 14-17=15.4μ; Ect. ap. 21×1μ; End. ap. 6×1μ; Exine 1μ.

C. rutidosperma DC. Candgia, *Bangui Audru* 3245, Pr. 20811.

P 17-24=20.8μ; E 13-18=14.95μ; Ect. ap. 16×1μ; Exine 1.5μ.

—— Herb. IEMVT *Prelev* 309, Bellevu , Pr. 21841.

P 24-27=25.4μ; E 17-20=19μ; Ect. ap. 22.75×1.25μ; End. ap. 5×4μ; Exine 1.5μ.

C. rutidosperma DC. Cote d' Ivoire, Pr. 37.

P 21-25=23.08μ ; E 15-18=16.64μ ; Ect. ap. 18×1μ ; End. ap. 2×3μ ; Exine 1.5μ

—— Congo, Mayumba, *Debeaux* 120, Herb. Montp. Pr. 33527.

P 19-23=21.52μ ; E 16-19=16.28μ ; Ect. ap. 19×1.5μ; End. ap. 2.6×2.83μ; Exine 1.5μ.

—— India, Calcutta, *Chanda, S. K.* 1, Pr. 24859.

P 20-23=21.95μ; E 15-17=15.96μ; Ect. ap. 18×1.5μ; Exine 1.5μ.

—— India, Coimbatore, Southern Circle, 11838. Pr. 9220.

P 16-21=18.36μ; E 15-16=15.75μ; Ect. ap. 15.75×1μ; End. ap. 2×2μ; Exine 1.5μ.

C. schweinfurthii Gilg. Arabie, Herb. IEMVT *Prelev* 313, Bellevue No. 1357, Pr. 21842.

P 28-33=31.45μ; E 26-28=26.9μ; Ect. ap. 24.5×3μ; Exine 1.75μ.

C. simplicifolia Hook. f. et Thoms. India, Gujrat, *Rao, R. S.* 63644. Pr. 24877.

P 30-33=31.68μ; E 20-23=21.38μ; Ect. ap. 23.2×2μ; End. ap. 5×4μ; Exine 1.5μ.

C. spinosa Jacq. Herb. Univ. Mich. *Lundel* 4168 (1933). Pr. 4653.

P 19-21=19.89μ; E 18-22=20.45μ; Ect. ap. 15.5×1.5μ; End. ap. 5×2.5μ ; Exine 1μ

C. tenella Linn. f. India, Coimbatore, Southern Circle 13629, BSI, Pr. 9227.

P 17-21=19.32μ; E 15-18=17μ; Ect. ap. 16×1μ; Exine 1.5μ.

—— Tchad, *Gaston Alfort* No. 221 (1964), Pr. 19855.

P 16-19=17.95μ; E 12-16=13.38μ; Ect. ap. 13.6×1μ; Exine 1μ

C. usambarica Pax Flore du Kenya Coll. *Curry et Glen* 66. Herb. Afr. Est. Pr. 33640.

P 15-17=15.68μ; E 11-12=11μ; Ect. ap. 12.5×1.25μ; End. ap. 2×1.5μ; Exine 0.5μ.

C. violacea L. Maroc, El Aricha *Wieller* 13527, Herb. Montp. Pr. 33514.

P 32-37=34.53μ; E 28-36=30.61μ; Ect. ap. 33×2μ; End. ap. 14×2μ; Exine 1.6μ.

C. viscosa L. Tchad, Koab. *Gaston* 333 (13.8.64), Pr. 20790.

P 31-37=33.16μ; E 22-27=23.66μ; Ect. ap. 24×2μ ; Exine 1μ.

—— India, Pondicherry, *Guinet, Ph.* 26.11.61. Pr. 9323.

P 30-40=34.04μ; E 19-27=23.84μ; Ect. ap. 25.5×1μ; End. ap. 6.6×6μ; Exine 1.5μ.

—— India, Calcutta, IBG. Pr. 7469.

P 27-35=31.4μ; E 20-26=23.4μ; Ect. ap. 25×2μ; End. ap. 5.5×3.5μ; Exine 1.5μ.

—— Arabie, Mazrub *Baumer*, Herb. Montp. Pr. 33533.

P 32-36=34.16μ; E 21-24=23μ; Ect. ap. 29×1.5μ; End. ap. 7×4μ; Exine 1.5μ.

Isomeris

Longiaxis, 3 colporate colpa long, slit like. Endoaperture elliptic with granules. Exine tectate non echinulate, reticulate.

Material studied:

I. arborea Nutt. California *Dr. Coulter* Acc. No. CNH 28326.

P 16-19=17.4μ; E 13-16=14μ; Ect. ap. 16×1μ; End. ap. 3×1μ; Exine 1.25μ.

Cleomella Plate II ; Fig. 12]

Pollen longiaxis, 3 colporate, colpa long, slit like. Endoaperture circular. Exine reticulate.

Material studied:

C. obtusifolia Torr. California, Mojave Desert, *Pringle, G. S.* 1882, Pr. 33522.

P 22-27=24.2μ; E 14-17=15.48μ; Ect. ap. 21×1μ; End. ap. 3.3×2μ; Exine 1.5μ.

C. longipes Torr. Mexique, *Schumann, W.* 1311, Herb. Montp. Pr. 24951.

P 18-21=19μ; E 12-14=12.8μ; Ect. ap. 14.5×1μ; End. ap. 3.5×2μ; Exine 1μ.

Wislizenia

Longiaxis pollen, 3 colporate, with more or less diffuse operculum, colpa long, slit like. Endoaperture oval with operculum. Exine reticulate.

Material studied:

W. refracta Engelm. California, Tulare lake, *Palmer,* 2701. Acc. No. CNH 28432.
P 19-25=22.35μ; E 15-18=16.2μ; Ect. ap. 19×1μ; End. ap. 6×4μ; Exine 1.5μ.

Dactylaena [Plate II; Fig. 14]

Pollen longiaxis, 3 colporate, colpa long, slit like. Endoaperture indistinct. Exine reticulate.

Material studied:

D. micrantha Schrad. Cultivé à Talance, *Neyrant* 1923, Herb. Montp. Pr. 33526.
P 20-26=23.75μ; E 12-15=13.65μ; Ect. ap. 21×1μ; End. ap. 2×3 μ; Exine 1μ.

Cristatella [Plate II; Fig. 13].

Pollen longiaxis, 3 colporate, colpa long, slit like. Endoaperature circular with few granules. Exine reticulate.

Material studied:

C. erosa Nutt. Texas, Dallas, *Reverchon* 1877. Herb. Montp. Pr. 24931.
P 17-20=18.64μ; E 12-14=12.64μ; Ect. ap. 16×1μ; End. ap. 3×2 μ; Exine 1.5μ.

C. jamasii Torr. et Grey Texas, *Trecul* 1217, Herb. Paris, Pr. 33523.
P 18-21=19.24μ; E 12-15=13.68 μ; Ect. ap. 15.6×1μ; End. ap. 3.5×2μ; Exine 1.5μ

DISCUSSION

On the basis of detailed pollen morphological observation on the different species of the family Capparaceae the pollen grains can be grouped into following types taking into consideration the aperture as primary and the exine as secondary characters.

Type I: Pollen colporate operculate
e.g. Cadaba & Wislizenia.

The pollens are ellipsoidal longiaxis or spheroidal equiaxis and isopolar. In polar view subtriangular. The number of aperture is three, equatorial and equidistant. The ectoaperture, colpa, is long, tapering. The endoaperture is circular or lolongate with a distinct operculum. Sometimes operculum is of diffuse nature and is constituted of teeth like granules. Exine tectate, 1-1.5μ, thick, the ornamentation echnulate or scabrate (supratectate) and reticulate or striatoreticulate (tectate).

KEY TO THE SPECIES

A Operculum well developed:	
B Endoaperture lolongate	*C. farinosa/fruticosa, C. mirabilis*
BB Endoaperture circular:	
C Pollen 26-27.71×8.28-19.5μ	*C. heterotricha, C. rotundifolia*
CC Pollen 30.8-39.8×22.5-24.26μ	*C. indica/trifoliata, C. glandulosa*
AA Operculum diffuse with teeth:	
B Exine echinulate or scabrate:	
C Striatoreticulate in between echinulate exine:	*C. kirkii*
CC Reticulate in between echinulate exine:	
D Pollen 23.32×16μ	*C. gillettii*
DD Pollen 26.5×21μ	*C. ruspolii, C. longifolia*
BB Exine non echinulate, reticulate:	
C Pollen 30.58×24.35μ	*C. juncea*
CC Pollen 22.35×16.2μ	*W. refracta*

Type II: Pollen colporate

Pollen longi or equiaxis, ellipsoidal or spheroidal, isopolar. In polar view subtriangular, 3 colporate. The ectoaperture, colpa, long, tapering or slit like. The endoaperture is circular, oval or lalongate with teeth like granules few or many, distinct or indistinct. The exine is tectate; echinulate, scabrate (supratectal) and psilate, reticulate, striatorecticulate, sometimes the columella are arranged in small striate groups (tectate). The columella may be short 0.5 to 1.5μ or long 2 to 3μ or more.

The pollens, included under this type are further grouped into sub types on the shape, exine ornamentation and other subsidiary characters.

Type II: Subtype A: Pollen echinulate

Group A1: *Columella long* (2 to 3μ) *e.g. Boscia, Maerua & Cadaba.*

The echinules are 0.5 to 0.75μ long and 1 to 2 μ apart. Tectum perforate. The species included are identified as follows:

A Reticulate ornamentation	*C. madagascariensis*
AA Striatoreticulate ornamentation :	
B Pollen 24.44 × 19.24μ	*B. coriacea*
BB Pollen 25.8-34.92 × 21.7-27.52	*B. longifolia, B. senegalensis & B. mossambiensis*
AAA Columella in small striate groups :	
B Pollen 34.92 × 27.52μ	*B. urens*
BB Pollen 25.8 × 21.7μ	*M. kirkii*

Group A2: *Columella short* (0.5 to 1.5μ) *e.g. Cleome & Capparis.*

This group includes mostly *Cleome* and only one species of *Capparis* which can be easily identified from *Cleome* as follows:

A Striatoreticulate ornamentation :	
B Colpi membrane granulated	*Capparis cynophallophora*
BB Colpi membrane non granulated	*Cleome decipiens & C. rosea*
AA Reticulate ornamentation :	
B Pollen 20.44 × 17.48	*Cleome anomala*
BB Pollen 28.56 × 19.44μ	*Cleome pungens*
BBB Pollen 34.84 × 33,1μ	*Cleome speciosa*
AAA Psilate :	
B Equiaxis	*Cleome spinosa*
BB Longiaxis	*Cleome leptorrachis, C. leptostachys & C. aculeata*

Type II. Sub type B: Pollen scabrate.

Group B1: *Columella long* (2-3 μ) *e.g. Capparis, Maerua & Thylachium.*

It differs from the former type by the very small size of the echinulates structure which appears almost granular. The species included under this type are following:

A Striatoreticulate ornamentation :	
B Pollen 37-48.42 × 30-33.57μ	*T. africanum & T. seyrignii*
BB Pollen 31.75 × 22.75μ	*T. angustifolium*
AA Reticulate ormamentation :	
B Pollen 23.32 × 17.84μ	*C. afzelii*
BB Pollen 32.15 × 30μ	*C. lundellii*
AAA Columella in small striate group :	
B Endoaperture with distinct teeth like granules	*M. duchesnei; M. edulis, M. pseudopetalosa*
BB Endoaperture with indistinct teeth like granules	*M. angolensis, M. apetala, M. crassifolia, M. nervosa M. nuda, M. ovalifolia, M. pedunculosa, M. rosmarinodies & M. triphyllair*

Group B2: *Columella short* (0.5-1.5 μ) *e.g. Capparis, Crataeva & Apophyllum.*

The species included under this group are characterised by their exine, size and ornamentation.

A Psilate :	
B Teeth few	*C. sabiaefolia*
BB Teeth many granular	*C. spinosa* var. *coriacea*
AA Reticulate ornamentation :	
B Polar axis mean over 25μ:	
C Endoaperture not clear	*C. heyneana*
CC Endoaperture clear :	
D Teeth few	*C. brevispina*
DD Teeth many	*C. breynia, C bequaertii & C pyrifolia*

BB Polar axis mean less than 25μ :	
C Endoaperture not clear	*C. fascicularis*
CC Endoaperture clear:	
D Lumina very fine (0.25-0.5μ):	
E Teeth few	*C. burmanica, C. horrida, C. zeylanica, C. excelsa*
EE Teeth many granular	*C. fusifera, C. olacifolia, C. multiflora, C. richardii, C. rothii, C. viminea, C. tenera & C. obovata*
DD Lumina 0.5-1.5μ	*Crateva adansonii, C. religiosa & C. roxburghii*
AAA Striatoreticulate ornamentation:	
B Polar axis below 25μ	*C. erythrocarpa & C. flavicans*
BB Polar axis over 25μ	*A. anomala, C. divaricata & C. prisca*

Type II. Sub type C : Pollen non-echinulate or non scabrate.

Group C1 : *Columella long* (2-3μ) e.g., *Boscia, Capparis, Ritchiea, Steriphoma.*

The sub type C differs from the former two sub types as the ektexine here is neither echinulate nor scabrate. The pollen types under the group C_1 are as follows:

A Reticulate ornamentation :	
B Pollen within 25μ	*B. salicifolia*
BB Pollen over 25μ :	
C Endoaperture lalongate	*B. angustifolia*
CC Endoaperture circular :	
D Teeth distinct	*C. avicenniaefolia, S. cinnabarium & S. paradoxum*
DD Teeth not clear	*R. albersii*
AA Rugulate or columella in small groups	*R. capparoides*

Group C 2: *Columella short* (0.5-1.5μ) *e.g., Capparis, Cladostemon, Cleome, Cleomella, Cristatella, Dactylaena, Isomeris, Koeberlinia, Neothorelia, Stixis, Atamisquea.*

A Psilate—Pollen 14-21 × 10-16μ	*C. spinosa, C. sicule, C. antanossarum, C. corymbosa, C. cartilaginea & C. sepiaria*
AA Reticulate ornamentation :	
B Pollen equiaxis (10.5-14.2 × 10.6-13.4μ) endoaperture granules not clear:	
C Hetrobrochate	*S. suaveolens*
CC Homobrochate	*S. fasciculata, S. obtusifolia, S. scandens & N. laotica*
BB Pollen longiaxis :	
C Pollen below 25μ	
D lumina very fine 0.5μ or less	
E Lumina less than 0.5μ	*C. parviflora, C. roxburghii & K. spinosa*
EE Lumina 0.5 μ — (Pollen 15.68-24.6 × 12.64-21μ)	*C. andamanica, C. cathacartii, C. cleghornii, C. diversifolia, C. grandis, A. emarginata Cl. eome usambarica, Cladostemon longipes, C. obtusifolia, Cristatella erose, C. jamesii, D. micrantha, I. arborea*
DD Lumina 1-1.5 μ	*St.longiracemosa*
CC Pollen over 25μ :	
D Lumina 0.5μ or less	*C. moonii & Cl. simplicifolia*
DD Lumina 1-1.5μ	*Cleome aspera, C. chelidonii, C. chodatiana & C. felina*
DDD Lumina 1-2.5μ :	
E Homobrochate	*Cleome monophylla*
EE Heterobrochate :	
F Muri thick	*C. angulata*
FF Muri not thick	*Cladostemon kirkii*
AAA Striatoreticulate ornamentation	
B Pollen below 25μ :	
Pollen 19.7-23.09 × 13-16.89μ	*C. grandiflora, Cleome areysiana, C. gynandra & C. rutidosperma*
BB Pollen over 25μ :	
C Pollen 25 × 16.2μ	*Cleome maculata*
CC Pollen 31.36 × 26.58μ	*C. viscosa*

Type III : Pollen colporoidate
e.g. Cleome.

The species included under this type belongs to *Cleome*. They are characterised by the aperture with the distribution of the granules. Here the granules cover about two third of the colpal length compared to the former types where these are localised to the central part only. The species are as follows:

A Reticulate ornamentation :	
B Pollen below 25µ (19.5-23.16 × 15.8-17.2µ)	*C. glauca, C. aurea*
BB Pollen above 25µ(27.48-38.45 × 19.9-31.6µ)	*C. amblyocarpa, C. brachycarpa* var. *angustifolia, C. angustifolia* var. *petersiana, C. africanum, C. diandra, C. schewinfruthii, C. colutoides & C. droserifolia*
AA Striatoreticulate ornamentation : Pollen 27.1-36.7 × 21.64-32.2µ	*C. arabica, C. paradoxa & C. violacea*

Type IV : Pollen colpate
e.g. Cleome, Dipterygium & Buchholzia

Under this pollen type the genera belong are *Cleome* and *Dipterygium*. This type comes closer to the colporoidate type but here the aperture granules occupy the entire colpal length. Moreover this type differs from the formers due to superatectal verrucate exine characters, which is not found in the colporoidate type but is found in certain *Cleome* species of the colporate type. But in those species the superatectal processes are of more echinulate nature. Therefore this pollen type with its aperture and exine character is quite distinct in the family Capparaceae. *Buchholzia* is pollen morphologically entirely different from all the capparaceous species studied here. The species can be identified as follows:

A Colpal granules distinct ; longi or equiaxis pollens:	
B Tectum perforate :	
C Pollen 19.32 × 17µ	*C. tenella*
CC Pollen 26.5 × 21.7µ	*C. brachycarpa*
BB Tectum non perforate :	
C Ektexine psilate in between verrcae : Pollen 15.6 × 14µ	*C. papillosa*
CC Ektexine reticulate in between veruceae:	
D Pollen small 21.69-23.9 × 17.95-18.5µ	*C. dumosa & C. glaucum*
DD Pollen medium 27.3-29 × 19.9-28.16µ	*C. chrysantha & C. gigantea*
AA Colpal granules not clear ; breviaxis pollen : Pollen 24-33 × 32-47µ	*B. coriacea & B. macrothyrasa*

Palynological findings: It is found from the present observation that (a) the pollen grain psilate and columella short is more abundant in the number of species and genera, followed by (b) exine scabrate, columella short or long, (c) exine echinulate, columella short, or long and (d) exine psilate columella long.

The exine psilate, columella short type is also rich in the number of genera. It is interesting to note that under this type is found an assemblage of the taxon of Cleomoideae and Capparioideae. The genera of the Capparioideae represent only one pollen type (colporate) and the groups under this type are *Capparis* with five groups under colporate pollen type and *Cadaba* with colporate operculate type. *Stixis* and *Neothorelia* are pollen morphologically distinct from the rest.

Under Cleomoideae *Cleome* alone represents three distinct pollen types *viz*. colporate, colporidate and colpate. *Wislizenia* is colporate with diffuse operculum like structure. The rest of the genera under Cleomoideae are with colporate, psilate, columella short pollen type. Beside Cleome the similar colpate type is also represented by *Dipterygium*. Although, *Buchholzia*, comes under colpate type it is altogether different from other Capparaceae species in its pollen characters *i.e.,* with large brevicolpate, breviaxis, 4 colpate pollen. The characteristic apertural granules are totally absent as are found in *Cleome* and *Dipterygium* species of the colpate type.

In the family Capparaceae both *Capparis* and *Cleome* are represented by the largest number of species. About 40 species of each genus have been studied palynologically in the present investigation. It is quite interesting to note that *Capparis* pollens are all colporate type only and are distributed under five groups. Whereas *Cleome* species represent only two groups under colporate type but it covers diverse pollen types *i.e.*, colporate, colporoidate and colpate. Truly speaking *Cadaba* and *Wislizenia,* which represent the operculate type actually come under the colporate type, where the endoaperture granules are fused to form a distinct operculum (Classical). The presence of diffuse operculum supports that the operculum (Classical) in Capparaceae is originated by the fusion of these granules and palynologically they represent the primitive type through colporate, colporoidate to finally colpate type of aperture of the *Cleome* and *Dipterygium* species, where these apertural granules are not localised at the equatorial region but cover quite larger area of the colpal length (Fig. 1).

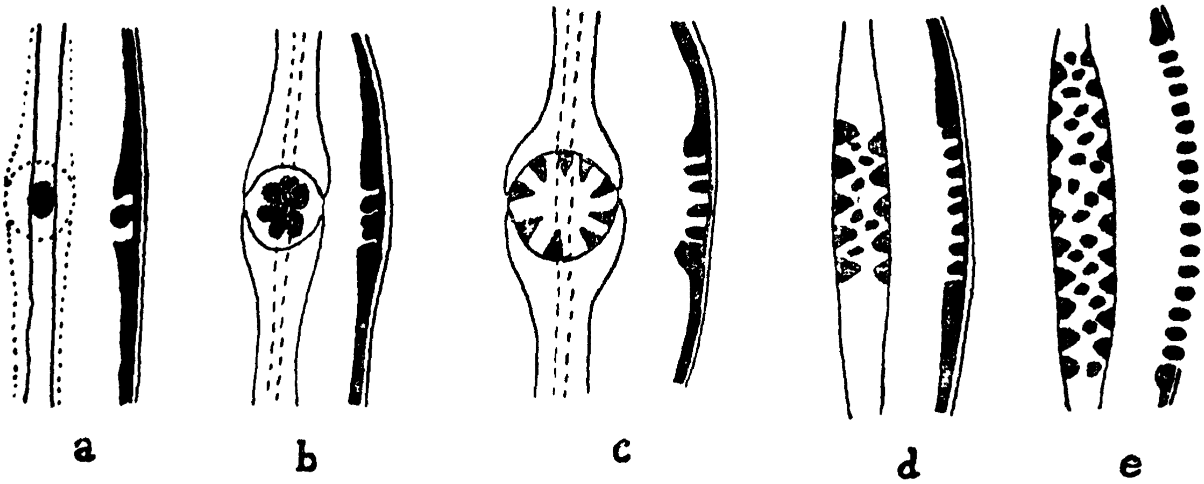

Fig. 1 : Diagrametic representation of the aperture types in Capparaceae. (a) Classical aperture, *e g. Cadaba* sp. (b) Diffuse operculum, *e.g. Cadaba juncea.* (c) Common colporate aperture with granules in most of the genera of Capparaceae. (d) Colporoidate type based on the distribution of granules, *i.e.,* about 2/3 of the colpal length *e.g.* certain *Cleome* sp. (e) Colpate type based on the distribution of the granules covering almost whole of the colpal length *e.g.* certain *Cleome* sp. and *Dipterygium.*

In their morphological characters also *Cleome* is advanced with herbaceous habit and capsular fruit. This is supported by the occurrence of similar granules in the highly evolved family Resedaceae (Mitra, unpublished).

Evaluation of the pollen characters: Palynological studies in the family Capparaceae shows that it can provide substantial informations towards a modern classification. The palynological data will be helpful from the point of view of phylogeny, phytogeography, paleogeography and paleobotany (Guinet & Mitra, unpublished).

Following conclusions are made from the present observation that the pollen characters can be used as a criteria at family, subfamily and tribe level.

Pollen grain size does not give any clue in the identification of taxa at specific level. Aperture and exine characters are main criteria in the palynological interpretation. In

Cleome species nature of pollen aperture and ssed morphology show good correlation (Fig. 2). Apertural granules associated with exine ornamentation are distinct characters in the family.

Correlation of palynological findings with taxonomy: Pollen morphological studies on the taxa in the family indicated two distinct subfamilies *viz*. Capparideae and Cleomoideae. In the former except *Capparis*, *Atamisquea* and *Koeberlinia* other genera are quite distinct from the Cleomoideae genera in their pollen characters. In the latter subfamily most of the genera are quite homogeneous in their pollen characters except *Cleome* which shows various evolutionary tendencies.

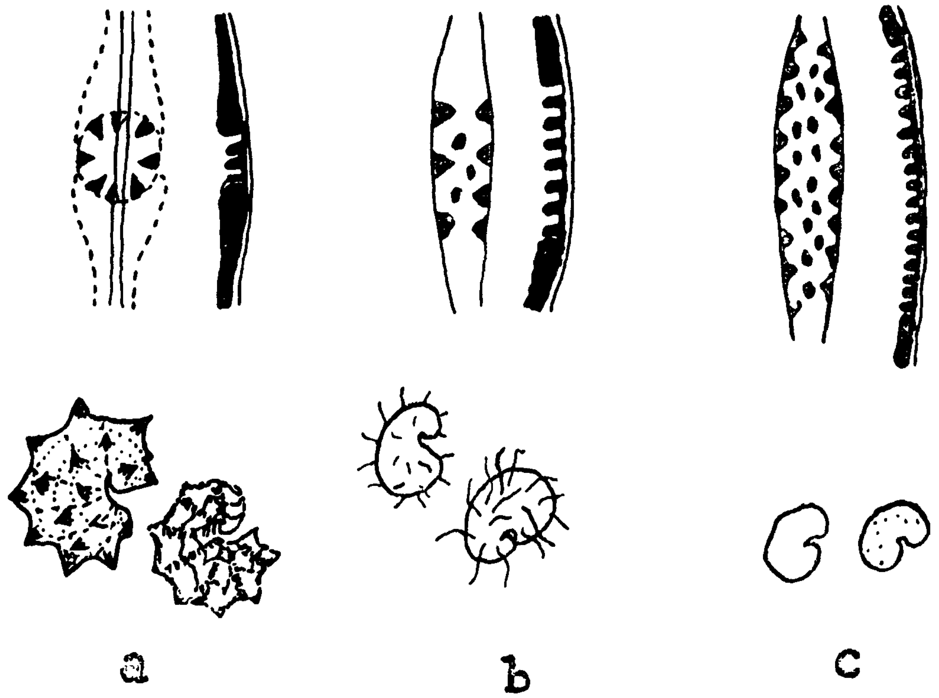

Fig. 2 : Diagrammetic representation of the correlation of aperture and seed character of *Cleome* species (a) Pollena perture colporate seed large with ridges and striation on seed surface. (b) Pollen aperture colporoidate seed medium with hairy surface. (c) Pollen aperture colpate seed small almost smooth or minutely pitted.

Pollen morphology does not recognise the subfamilies Buhsioideae and Dipterygioideae as in their pollen characters, *Buhsia* resembles to the colporate and *Dipterygium* to the colpate types of pollen grains of the *Cleome* species.

The tribes recognised by Pax & Hoffman and Bentham & Hooker are pollen morphologically justified. But pollen character does not recognise the tribe Koeberlinieae under the subfamily Capparioideae (sensu Pax et al.) but prefers to place *Koeberlinia* near *Capparis*, *Atamisquea* and other Cleomoideae genera.

Pollen morphological studies do not support separate family status—Koeberliniaceae as suggested by certain botanist and *Koeberlinia* is quite fitted in the Capparaceae.

The tribe Stixeae, although quite distinct, is rather doubtful under the family Capparaceae. The two genera studied *Stixis* and *Neothorelia* are quite alike in pollen and many morphological characters. The small equiaxis pollen with indistinct endoaperture, distinct reticulate exine and trimerous floral characters indicate certain doubt about its position. It requires further studies on the tribe and the taxa included there.

Palynology does not support the family status for the subfamily Cleomoideae nor it prefers to assign *Wislizenia* under Oxystylidaceae (fam. novo affinis Cleomaceae) as suggested by Hutchinson. Palynologically *Wislizenia* resembles certain *Cadaba* species.

Thus the family concept of the Capparaceae remains the same as proposed by Engler *et al.* and Bentham & Hooker. Palynologically it is felt quite unjustified to split it up into Capparaceae, Koeberliniaceae, Cleomaceae and Oxystylidaceae.

Phylogenetic relationships: The family Capparaceae is closely related to the Resedaceae in its pollen characters. The presence of myrosin granules and the character of stomatal aperture (Metcalf & Chalk, 1950) in the two families indicate their closeness. The occurrence of zygomorphic flower, parietal placentation and dry country habit further support their phylogenetic relationship which is strengthened by allied pollen characters of the two families.

The order Rhoeodales (sensu Engler) comprises of six families *e.g.*, Papaveraceae, Cruciferae, Capparidaceae, Tovariaceae, Resedaceae and Moringaceae. This family concept of Rhoeodales is much changed in the recent years and many of these families are recognised as distinct order as Papaverales, Capparalea, Resedales etc. It will be rather premature to speak how far from the palynolological point of view such seggregation is justified. Detailed palynological studies on the families Papaveraceae and Brassicaceae (Cruciferae) will be essential to comment on the phylogenetic relationships of the Rhoeodales. Pollen morphologically Capparaceae is quite different from the families Tovariaceae and Moringaceae.

ACKNOWLEDGEMENTS

I acknowledge my deep sense of gratitude to Mme. M. Vancampo, Directeur, Laboratoire de Polynologie (CNRS), Faculte des, Sciences, Montpellier (France) for her constant help, encouragement and her kind permission to study the vast collection of the pollen slides of the family Capparaceae and other families. I express my profound gratitude to Monsieur Ph. Guinet, Directeur ad-joint of the said laboratory for guiding throughout the course of this work inspite of his various engagements. It is a pleasure to thank all the collaborators of Mme. Vancampo for their various help. I thank the French Government and the Centre International des Stagiers, Paris for the financial help.

My thanks are due to the Government of India and the Director, Botanical Survey of India for deputing me to France for Palynological training under Indo-French Cultural Exchange Programme and to the Deputy Director, Indian Botanic Garden for facilities. Lastly I thank the Keeper, Central National Herbarium for the polliniferous material of the Indian species and to Deputy Director, Central National Herbarium for critically going through the manuscript.

REFERENCES

BENTHAM, G. AND J. HOOKER. Capparidaceae in *Genera Plantarum* 1 : 103-110. 1862.

CANDOLLE, A. P. de. *Prodromus systematis naturales regni vegetabilis Capparideae* 1 : 237-254. 1823.

ERDTMAN, G. *Pollen morphology and plant taxonomy Capparidacea*. Hafner Publishing Company, New York & London, 1952.

FAEGRI, K. AND J. IVERSEN. *Text book of pollen analysis.* (2nd ed.) Blackwell, Oxford, 1964.

*GAUDICHAUD, Ch. *Voyage autour du monde sur la corvette la Bouite Commandée par M. Vaillant Historie naturelle, Botanique Atlas*. Paris, 1842.

GUERS, J., D. LOBREAU CALLAN., M. TH. DIMON, J. MALEY AND CAMBAU BAOG. Palynology africains XI *Extrait du bulletin de l'institut fondamental d'Afrique Noire.* Tome XXXIII, series A, No. 2 Daker IFAN, 1971.

GUINET, PH. Pollen of *Capparis divaricata in* Pollen As. trop. I. *Inst. Fr. Pondicherry Trav. Sec. Sci. Tech.* 5(1) : 1-8. 1962.

HADDAD, M. Quelques pollens de la flore libanaise. *Pollen et Spore*, 11(1) : 39-63. 1969.

HARMS, K. Rhoeodales *in* Engler und Prantel "*Die naturlicher Pflanzenfamilien* Band 17b. Dunker et Humblot, Berlin, 1960.

*HEUSSER, C. J. *Pollen and spores of Chile*. Univ. Arizona Press, Tucson, 1971.

HOOKER, F. AND THOMPSON. Capparidaceae *in* Hookers' *Flora of British India* 1 : 167-180. 1872.

HOROWITZ, A. AND B. BAUM The arboreal pollen flora of Israel. *Pollen et Spores* 9(1) : 71-73. 1967.

HUTCHINSON, J. *The genera of flowering plants*. 2 : 303-317. 1967.

——*Evolution and phylogeny of the flowering plants*. (Cruciales) Academic Press London & New York, 1969.

IKUSE, M. *Pollen grains of Japan*. *Capparidaceae* 79. Hirokawa Publishing Co. Tokyo, 1956.

JACOBS, M. The genus *Stixis* (Capparidaceae) A census. *Blumea* 12(1) : 5-12. 1963.

JAIN, R. K. AND S. NANDA Pollen morphology of some desert plants of Pilani, Rajasthan. *Palynological Bull. Lucknow* 2&3 : 56-69. 1966.

MALEY, J. Contributions a l'etude du Bassin tchadien. *Bull. Jard. Bot. Nat. Belg*. 40 : 29-48. 1970.

METCALFE, C. R. AND K. CHALK. *Anatomy of the Dicotyledons* I. Oxford, 1950.

MITRA, KRISHNA. Pollen morphology of some Indian Capparidaceae. *J. Indian bot. Soc., Madras* 49: 136-141. 1970.

——. Resedaceae in 'Palynological studies on certain families of Angiosperms in relation to Taxonomy. Ph. D. Thesis, Calcutta University, 1974 (Unpublished).

MOHL, H. VON. *Beitrage zur Anatomie und Physiologie der Gewachse*. Erste Heft. Uber den Bau und die formen der Pollenkorner. Bei. Chr. Fischer und Comp. Bern, 1834.

NAIR, P. K. K. Significance of pollen and spore in investigation of medicinal plants. *Palynological Bull., Lucknow* 5 : 119-122. 1969.

PAX, F. AND K. HOFFMAN. Capparidaceae *in* Engler and Prantel "*Die Naturlichen Pflanzenfamilien*" band 17b. 146-223. Dunker et Humblot, Berlin, 1960.

SELLING, O. H. Studies in Hawaiian pollen statistic. Part II pollen of the Hawaiian phanerogams. B.P. *Bishop. Museum Special Pub*. 38 : 1-130. 1947.

VANCAMPO, M. Palynologie Africaine I. *Bull. I.F.A.N.* 19(A:3) 659-678. 1957.

*ZINDERN BAKKER, E. M. VAN. *South African pollen grains and spores*. III : 1-132. 1956.

**Not seen in original*.